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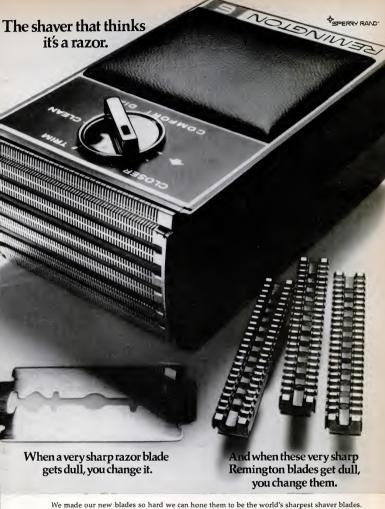
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THE What'S New MAGAZINE"

MAY 1970 Founded in 1872/Vol. 196 No. 5

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Ford's New Smog-Free Engine PAGE 55
PS Detroit Editor Jim Dunne tells you the inside story of how Ford developed the stratified-charge fuel-injection engine

Your Guide to Action-Packed Travel PAGE 76

Giant U.S. travel map in color-keyed to more than 200 exciting events you'll want to see. Guide tells when and where they happen.

How to Beat the High Cost of Body Repairs PAGE 122
Ding out your own dents—you can do it easily, at small cost.

World's First TV Broadcast Satellite

By WERNHER von BRAUN PAGE 64 India will skycast direct to her remote villages via a U.S. satellite.

The Case for Central Air Conditioning PAGE 67
Which system will suit you best? What does 24-hour house cooling cost? COVER PAINTING BY RAY PIOCH

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TROLLING IS AN ART THAT CAN **IMPROVED** WITH SCIENCE

by Bob Cobb



Trolling will often produce fish when no other method works

You couldn't hold a boat to fish. The wind was howling. And, the temperature would boil a coffee pot. But to see Sam Jackson, Jr. struggling to haul a stringer of fish to the dock, you'd bet your fishing hat conditions were "A-Okay."

"Where did you have those fish staked out? You couldn't have caught them to-day," noted a wide-eyed skeptic who sauntered down to the dock.

sauntered down to the dock.

The skepticism wasn't surprising; 22
white bass and five black bass add up to
a respectable score. Sam and I had
caught them all trolling.

The apparent simplicity of trolling dupes some observers into thinking this effective technique is a matter of dunking a lure overboard and revving up the motor. Trolling demands a measure of knowhow for results. A

successful troller has an understanding of the waters he fishes. With a sonar bird dog like the LO-K-TOR you can discover the 'breaks" in underwater structure, as a sharp drop-off on a sloping ridge. You can follow

more accurately the direction of underwater bars and reefs; areas where fish conFICH FISH LO-K-TOR ... L Park

Old creek channels are Old creek channels are ideal trolling areas. Exact location and proper depth can be determined with Lo-K-Tor.

centrate. You can find underwater weedbeds, brushpiles and treetops.

A successful troller is constantly experimenting with boat speeds, various fishing depths and an assortment of lures. Trolling can be just as scientific as you want

to make it. Here's a LO-K-TOR technique that helped us beat the summer slump. Sam



Increase fishing fun with a scientific Fish Lo-K-Tor

See how the Fish Lo-K-Tor finds fish. Your sporting goods dealer has a special demonstrator display you operate your self! Portable and guaranteed. \$169.5

For installing on your boat! your boat:
New Depth Sounder
and Fish Locator
Two instruments in
one, with special
high speed transducer. Gimbal mount.
\$169.50



used the sonar depth finder to follow an old creek channel in the lake, which evidently was cooler. The fish were using the deeper channel as their "air conditioner.

One of the key factors in selecting a lure for trolling is the depth it runs. ve used the LO-K-TOR to classify lures in my tackle box by

the bottombumping level of each. The LO-K-TOR showed fish at 18-feet deep in the channel, Diving plugs were used. Examina-

Adding jlg to deep diving lure puts bait at ievel of fish.

tion of the first white bass's stomach tion of the first white basis stomach showed small shad. The score really picked up when we tied a 1/16-ounce white marabou jig on an 18-inch drop line tied to the plug's front treble hook. Attaching it to the forward hook digs the plug deeper.

The thing that makes trolling successful is that you've always got your bait in the water," said Jackson. "You don't get many strikes with it in the bottom of the boat . . . running from one spot to another. For a serious troller, a FISH LO-K-TOR

ranks in importance with his boat and outboard motor.

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Last year thousands of fisher-men bought The Fun of Elect \$1.00 price (regular price \$2.00), so we are offering it again this year for a limited time. It is better fisherman or your \$1.00 will be refunded. Learn how with a Lowrance Fish Lo-K-Tor. Thousands sold at \$2.00 each. Special \$1.00 offer good of the price of the price



Inrough may 31, 1970.

Enclosed is \$1.00 for The Fun of Electronic Fishing. If I am not a better fisherman after reading it, I will return it for a full refund.

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At 2000 miles, the detergent in your oil is all washed up.

The oil's still good, but the detergent's long gone.

You can either change the oil, or add CD-2 Black Label.

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You can also ignore our advice and come back later.

When you're ready for CD-2 Red Label. It's for oil burners.

No all purpose additive can do either job as well.







Better late than never.

What's New

What the New Lead-Free Gas Will Mean to You

Engines will have to change, too. Oil-change intervals may be affected—and the price you pay for gas. Here's the whole story

RCA's "4-Ring-Circus" TV

Wild new multi-screen television set lets you watch four shows at once—and switch to where the action is!

GE's New Battery-Powered Tractor

This first production electric tractor will mow seven acres of lawn on one charge, and power your electric tools, too

Announcing the Winners in the PS Anti-Car-Theft Device Competition

The lucky inventors and ingenious gadgets that won prizes in the \$25,000 Allstatesponsored contest to balk car thieves

Go Camping on a Motorcycle?

Sure. And Jim Davis tells you how to do it, for a different kind of outdoor adventure

Sneak Preview:

What's Coming in '71 Cars
Our Detroit operative, Jim Dunne, lifts the
veil on next fall's crop of new models

Checklist for Your Boat

What you should know about your boat, and the power plant that runs it, to keep your rig shipshape for safe, trouble-free fun

Plus: The Coming Revolution in Modular Housing . . . Station-Wagon Camper You Can Build . . . Amazing Color Effects with Polychroic Film . . . Booming Hobby: Homebuilt Planes . . . and more

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The editors of POPULAR SCIENCE deeply mourn the loss of Erle Stanley Gardner, who died on March 11. The noted mystery writer, who contributed many feature articles to this magazine, also served as our consulting editor in the field of off-road vehicles and the joys of outdoor adventure.

The only thing standing between you and a Renault 16 is a little information.



you experience in the Renault 16 "can be compared only to that of the Mercedes, Rolls, or Citroën."*

Colin Chapman chose the engine of the Renault 16 for his Lotus Europa.

And the quietness of the Renault 16 (which goes for a mere \$2,395†) comes only in cars costing thousands more.*

Someone is sleeping in Detroit.

Road Test is an impartial magazine. At the time of this writing, it did not even take advertising. After exhaustive tests on the Renault 16. Road Test wound up suggesting that "all the automotive designers in Detroit be ordered to spend two weeks behind the wheel of this car in the hopes that their dormant imaginations might be sparked to life." Thank you, Road Test.

A textbook for Britain.

Stirling Moss has written: "There is no doubt that the Renault 16 is the most intelligently engineered automobile I have ever encountered and I think that each British motorcar manufacturer would do well to A ROAD TEST MAGAZINE, TSUGGESTED RETAIL PRICE, P.O.E. TAXES, FREIGHT, OPTIONS (SUICH AS AUTOMATIC TRANSMISSION, FLEC

purchase one just to see how it is put together.'

The Renault 16 happily consents to offering a course in Renault 16.

Where we made our points.

Needless to say, our car has impressed a lot of people. We'd like to tell you why.

Before our car was a car, it was a project. It was designed and built from scratch. Like the factory that makes it. So we didn't build a new car around old parts.

For better traction and superior road handling, the Renault 16 has front wheel drive with engine weight over the drive wheels.

Its engine gets a miserly 30 miles per gallon. But it does an honorable 93 mph, top speed.

Its unique 4-wheel independent suspension system has already put the 16's ride in a league with the Rolls Royce's.

The seats in the 16 were designed by a doctor and will challenge the comfort of any easy chair. They too have been compared with the Rolls'.

Even more points.

Disc brakes resist fade. Our front wheel disc brakes will stop you in a straight line instead of the next lane.

Seven different seating arrangements give the Renault 16 perhaps the most versatile interior you can drive. It can be a plush sedan, a roomy wagon, or anything in between.

It's got a sealed cooling system that doesn't overheat and virtually eliminates adding antifreeze.

And finally, the sound of a Renault 16 running is very close to silence

Extracurricular reading.

If any information still stands between you and a Renault 16, you can have Road Test's full report on it by sending in the coupon below.

But if you've read this far, we suspect you're at least ready for







Brad Shoop; 41lb. 10 oz. Muskie

Rapala Power Produces Another Trophy "What a fight," says Brad Shoop, Rosemount, Minn. "I couldn't believe any fish had so much power." While the fish shook Brad, it didn't shake the Rapala. That's because Rapala is the lure for trophy Trout. Walleyed Pike, Bass . . . all trophy fresh and saltwater gamefish. Available in floating and sinking models — 7 sizes, 3 colors. At all dealers.

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PS Readers Talk Back

Where you voice your views . . . and the editors do the listening



Diving for fun

As a professional scuba-diving instructor and an avid sport diver, too, I really appreciated Cmdr. Scott Carpenter's "Scuba Diving for Fun" [Feb.]. It will not only increase my class size, but also cause a large number of people to become acquainted with the greatest sport in the world. I also appreciate the value you place on taking a diving course as a proper way of learning to dive.

However, there is one point you failed to mention that I feel is vital. Any diving course should be sanctioned by a nationally accredited organization such as NAUI, PADI, or the YMCA. In going to an accredited diving organization, the student is almost assured of getting a competent teacher. WILLIAM PERLMUTTER, Houston, Tex.

Top of the rocket

What is the Saturn V rocket's whole top stage as described in your article "How Apollo 13 Will Probe the Moon's Interior" [March]? Is it the stage the LM is in at liftoff, or the service module? If it's the service module, how will they get back to the earth?

MIKE SCHWEIGER, Mt. Vernon, Mo.

The "whole top stage" consists of the third stage (S-IVB) and the attached Instrument Unit. This portion does not include any part of the Apollo spacecraft (Command, Service. and Lunar Modules) which will have separated from the Saturn V third stage at a much earlier point in the journey to the moon.



Tells where ATVs ought to go

I am sorry to see yet another article glorifying speed and recklessness in the use of All-Terrain Vehicles-Erik Arctander's "Your first Ride in an ATV" [March].

With our present highway laws all but unenforceable, how can we cope with a flood of unsupervised ATVs swarming over the fields and forests "roaring full-bore through the brush?" Does anyone really want this kind of debasement of our quality of life and natural resources?

Let those who must operate ATVs band together and buy their own real estate where they can roar around without annoying campers and hikers trying to escape from the traffic that pervades almost every other spot. The sooner the lawmakers get to work on this, the better for the cause of environmental preservation and quality of life in the U.S. Dr. John R. Phillips, Hammond, Ind.

. . . ATVs are cute, but I can already envision numbers of these broken-down playthings abandoned across the countryside, just as myriad autos are now left unclaimed in our cities. The best ATV is that ultimate of engineering-man.

JOSEPH R. SHEEHY, Medina, O.

Geography lesson

Norbert Aubuchon, the author of "Island Hopping" [March] makes an error common to American students of geography. The Bahamas are in the Atlantic Ocean and not in the Caribbean Sea, The Caribbean is contained by the south shores of Cuba and Haiti. It osculates the Atlantic in the Windward passage between Cape Maysi, Cuba,

and Cape St. Nicholas Mole, Haiti. This is about 50 miles south of Great Inagua, the southernmost island in the Bahama chain. ALDEN BARBES



Pittsburgh, Pa.

Counter argument to bigger PS

My only objection to the new size is that it doesn't fit on the lunch counter. I always buy PS on the newsstand and read it at lunch. Now it takes up too much room.

DERECK WILLIAMSON, Asbury, N.J.

Have you thought about switching to table service?

Wagon talk

I'm disgusted with the N/D Report on "Deluxe Wagons" [March]. The Chrysler and Dodge wagons are biggest in practically all dimensions. Isn't this what makes a luxury wagon-huge amounts of interior and cargo space, and

a certain touch of luxury that sets them apart from the other wagons? What can whipping these monsters around a sports-car course prove for these purposes?

ROBERT A. NOLFI II McKees Rocks, Pa,



Our handling tests are maneuvers that can be duplicated on a straight road or a runway. We do not conduct any tests involving timed laps on a road course.

When your kid starts telling you what oil to use, listen.



He may be your kid. But that's no kiddy-car he's driving: a 390-cube, 4-barrel V-8, four-on-the-floor muscle

machine he has purring like the family kitten.

He knows cars. He knows motor oils. That's why his motor oil is Quaker State. It's refined only from 100% Pure Pennsylvania Grade Crude Oil, the world's best natural lubricant. Then it's fortified to protect an engine even more than any car maker's warranty demands.

Next oil change, do like your resident car expert. Ask for Quaker State wherever they care about cars. It does great things for your engine.

And your peace of mind.

Quaker State your car to keep it running young.

its own good Lights easy-takes its own time about I he Lazy Pipe Tobacco nis way; on a single pipeful of Bond Street you can travel couple of relaxing miles in a cance, without even lifting to the subject of the subject of the subject part of the Bond Street taste to your liking (and don't be surprised if a passing sportsman has some This gentle-tasting tobacco has just the right combination of and steady burning. flakes for smooth plugs and flakes for si Think of it this way: on a single pipeful of I a couple of relaxing miles in a

What our tests prove is that some cars have more controllable behavior than others in an emergency situation. We maintain that this is a measure of operational safety.

... The main reason I buy PS is because of the fact-filled Norbye/Dunne reports. They include the things people really care about when they buy a car, such as visibility, fuel mileage, brakes, and all-around performance. Keep up the good work.

LARRY MARSH, Gainesville, Fla.

... Where the deluxe wagons offer them as options, my 1970 Volve wagon comes with heated rear window, rear washer? wiper, and constant-temperature air induction system—all standard equipment. So are two large outside mirrors, with tinted glass to reduce glare. The Volve seats are famous for their comfort, and the engine looks lost in the compartment provided—there is so much room to get at everything from the top. Four-wheel disk brakes are standard, too. Detroit would do well to adopt some of the ideas used on European cars.

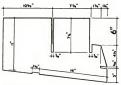
Lr. J. R. SHANNAHAN, Andrews AFIS.

Lt. J. R. Shannahan, Andrews AFB. District of Columbia

Paperboard chairs

I found Lester Walker's challenging "Could You Bend Up A Chair From Paperboard?" [Feb.] very interesting, but in making a scale model of the chair I ran into a problem. I believe there is an error in the dimensions of the center piece.

SCOTT STIBITZ, Carbondale, Ill.



Right you are. Instead of 13¾" in the top right corner, it should be 6" as shown above.

Rap on the knuckles

Congratulations on your new format. But I did not start this letter with intent to praise; I was triggered by finding a couple of mistakes:

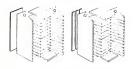
In describing the thickness of protective metallic films deposited to protect modern razor-blade edges ["How Science Gives You a New Edge on Shaing," Feb.] you say "an angstrom is a little bigger than a millionth of an inch." One millionth of an inch is equal to 254 angstroms.

Rather than congratulating "Seacamper . New Breed of Trailer/ Houseboat" [March] for squeezing the 17 feet of cabin width into an eight-oto beam, I guess we will have to rap your knuckles for being over-enthusiastic. Photos showing the cabin superstructure a bit narrower than the eight-foot beam would suggest that the cabin is seven feet

KENNETH H. MOORE, Troy, N.Y.

Thanks for setting our micro-inches and feet in order.

Some words about Wordless Workshop I liked your "Wordless Workshop" for February, but I have one adjustment. Your shirt caddy is just right, except at the back. I would not put a solid board



there. A certain amount of dust and lint will come off the shirts and would pack up at the bottom of each pocket and could not get out. I would put in at least three slats instead of a solid board.

R. Walsh, Jr., Summit, N.J.

Buying tip

Where can I purchase the bronze gear pump specified in "Let High-Pressure Water Wash Your Car" [March]?

STEPHEN J. ERST, Fort Wayne, Ind.

The pump is an Oberdorfer 2000B. Our author bought his from M&H Tool Supply, 1900 N. 2 St., Minneapolis, Minn. 55411. Price is \$12, Ireight collect. The pump must be cleaned in lacquer thinner to remove resin that has been pumped through it.

Foot power vs. horse power

Nitrogen dioxide, nitrogen oxide, and nitric acid resulting when combined with water are among the most dangerous components of combustion-produced pollution. No smog device will remove them. That makes air pollution control by modification of combustion systems a waste of time. There is simply too much combustion today—most of it in automobiles.

Cars are being used for more and more short trips. This, in a country with an overweight problem which spends great sums for exercise machines. We should use bikes for short trips.

R. E. AUGUSTINE, Hamilton AFB, Calif.

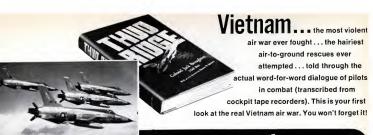
Apartment workshop woes

Apartment-dwellers who like to work with wood and metal need your help. For some reason, those people downstairs object to my hammering, sawing,

and drilling. I'd like to be a good neighbor, but I'd also like to continue my shop work. Could PS, or its readers, offer noise-deadening suggestions?

S. Weber, New York, N.Y.

Want to get something off your chest? Write "Readers Talk Back," Popular Science, 355 Lexington Ave. New York, N.Y. 10017.



Col. Jack Broughtan, U.S.A.F. (Ret.) was on continuous active duty with the U.S. Air Force from the with the U.S. Air Force from the day he received his wings until his retirement in September of last year. He flew 216 combat He flew 216 combat missians in his career, including 102 against Narth Vietnam. From 1965 to 1967 he was Vice-Commander of the Thoiland-based 355th tactical fighter wing and has been award the Air Force Cross "for extraordinary



by Vietnam Air Veteran Colonel Jack Broughton, U.S.A.F. (Ret.) Introduction by former New York Times Military Editor, Hanson W., Baldwin

IT WAS ABOUT TWO YEARS AGO, Jack Broughton was leading F-105
Thuds' over North Vietnam. The routine was pretty consistent: they'd
string of small, jagged mountains – Thud Ridges – that led them to their
arget area. It was in and around Thud Ridge that the most violent air war
n history was fought.

The story is told "just as it happened" — transcribed from a cockpit spe recorder that Jack Broughton kept running while in contact with

THE ADVERSARIES Broughton tells us that there were five kinds of 'enemy': the Migs, the Sams, faurface-to-air missiles), the weather, the ground fire - and, Broughton asserts, our own top brass who had a endency to foul things up for the Thud drivers.

The bigs were feet with executable, beautifully engineered aircraft—and they would have really done us in, except for the fact that the Mig drivers were lossy pilots. The author tells how it is to watch a "Sam" being aurched at you from the ground. . . its rular quidance system transitiantly aurched at you from the ground. . . its rular quidance system transitiantly evel, afterburners "plugged in", knowing that the farmers shooting at you with hand guar might hit a critically week spot on the Thud.

... and whether or not you tend to agree with Broughton's view of Air Force Brass, his opinions do not make dull reading.

RESCAP In this new kind of aerial wafare, a Thud driver could be apped thit by enemy fire) and find hisself on the ground, alive and in progression of 10°S. Thuttoms, and AES me piece minuted later. Then a progression of 10°S. Thuttoms, and AES could be a progression of 10°S. Thuttoms, and AES could be a progression of 10°S. Thuttoms, and AES could be a progression of 10°S. Thuttoms, and AES could be a progression of 10°S. Thuttoms, and AES could be a progression of 10°S. Thuttoms and AES could be a progression of 10°S. The superior and the progression of 10°S. The superior alive progression of 10°S

It seems that Leo, who was driving a Weasel (a Thud specially equipped o hunt Sam launching sites) got tapped. He made a successful ejection, and his battery beeper told a skyful of Thuds and Phantoms approximately

process as was.

Everybody knew that the North Viets were pressing through the jungle all around Leo, and the name of the game was "Let's get to Leo first."

But it want Leo's day, Rualo problems developed—and then reducing the incredible: Our birds were ordered home when Leo's rescue was finness in the bag.

amost in the ong.

Broughton tried for four days to get Leo out. Each time he returned, so is besper was weaker and harder to find (batteries don't last forever). In the fourth day, the besper came in loud and clear again, Broughton sked for Leo's voice and he got a prompt response — with an oriental sceent. The mission was finished.

ecent. The massion was mustbed:

Thus driver who took a hit in his hymerother has been been as the story about a say volud in Mag., He knew his budgies would slow down to keep him inside of their defenue envelope— even bought his would make hem suiting ducks. So he dropped the external househ this would neak he had the dropped the external hadden of the same that the same that the hadden of the same that the hadden of an entire Mig flight. Nothing scares a Mig driver more than the hought of a midster collision— and they scattered life rabbits.

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Autolite plugs in our Indy winner was enough But you're tougher on yours."

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Detroit Report...

HORSEPOWER RATINGS OF 1971 CARS will dip across the board as the companies make a massive move to lower compression ratios. Objective is to build engines that will operate on low-octane lead-free gasoline. Compression ratios will be brought down to about 8.2 to one. That will enable them to run on the 92-octane lead-free gasoline that petroleum companies will market later this year. GM will change all ite '71 enginee to run on regular fuel, and Ford and Chryeler will follow.

Chevrolet will have four different models of the XP887 next September. In addition to the basic two-door sedan that will sell for under \$2,000. Chevrolet will make higher-priced three-door-sedan. GTcoupe, and station-wagon versions. The GT model will sell for about \$3,000 and feature bucket seats, four-speed transmission, and a high-performance engine. Chevy will modify the new 140-cu.-in. aluminum engine to bring it up to about 140 horsepower for the GT model, giving the 1,900-pound car a very favorable power-to-weight ratio.

West Coast-bound XP887 cars will be shipped on closed railroad cars, using the Verta-Pak system developed by GM and Southern Pacific that carries the cars stacked on their noses. At least eight separate changes were made in fluidholding areas of the XP887 to prevent spillage while the cars are on end. A check valve in the carburetor prevents gas leakage; the oil-filler tube is set at the rear of the engine; the radiator overflow is blocked; windshield-washer bottles are sealed at the top; baffles in the engine prevent oil from gathering at the front bearing and in the front of the cam cover; the differential is also baffled and the transmission filler tube reshaped to retain oil. Chevy will save an estimated \$20 per car by shipping on the Verta-Pak system. In addition, soaring insurance rates due to vandalism and theft are expected to nosedive for cars shipped on Verta-Pak trains.

Chrysler's mini-compact 25-car will be delayed six months as part of an overall spending-cutback program. Another reason for the delay, according to unofficial sources, was indecision on the part of Chrysler officials over possible last-minute changes in the mini-car. Best information now says that the car will be introduced in the fall of 1971. The extra delay will add to Chrysler's disadvantaged position in the mini-car field, since GM and Ford will have models on the market a whole year earlier. American Motors' Gremlin has an 18-month jump on the 25-car. Chrysler is expected to use its 170-cu.-in. six-cylinder engine for the mini-car. The 25-car chassis will be a derivative of the Valiant, and one possible body style is a three-door design with a rear-facing back seat. That would add a "doorgate" of some type.

The heavy rubber bumper pioneered by Pontiac will be used by both Ford and Chrysler on some of their sporty models next year. In addition, you will see more use of thin ruhber coatings over the unchromed steel bumper as the automakers move to reduce corrosion and low-speed collision damage. Eventually, the rubber bumpers will be used with special shockabsorbing systems that will withstand collisions up to 10 mph without extensive body damage. In the impact-absorbing design, bumpers must extend at least six inches out from sheet metal. They retract without touching the fenders or hood for this distance, absorbing the collision forces before the sheet metal is hit.

GM plans to consolidate engine programs to reduce duplication. Eventually, the company plans to build engines at one division, then distribute them to the others. Pontiac, Chevrolet, Oldsmobile, and Buick have duplication in the 350-, 400and 455-cu.-in. sizes, all V8s with only minor differences between them. Currently, Chevrolet builds all six-cylinder engines for the corporation, supplying Pontiac Tempest, Oldsmobile F-85, and Buick Skylark as well as its own Chevelle and Nova. Under the proposed plan, the other divisions might be similarly assigned responsibility for designing and producing one V8 engine size each. GM asked engine-building equipment suppliers to submit bids for new engine manufacturing lines that would be needed under such a plan.

Tire companies in the U.S. are gearing up for mass production of the top-quality steel-belted radial tire. Now built only in Europe, the steel-cord radial made by Michelin is standard equipment on the 1970 Lincoln Mark III. Its use is expect ed to spread here in coming years for two reasons: 1) The Michelin tire gives the Mark III a far superior ride compared to bias-belted tires that are used as stand ard equipment on almost all other U.S cars 2) New machinery to automate radial-tire construction is on order and suitable steel cord will be available Goodyear has started a new wire plan in Europe to supply its needs.

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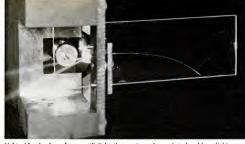
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Science Newsfront

Last-minute news and notes to keep you up-to-date

By ARTHUR FISHER



Lightguides for laser beams will light the way for complex optical circuits no larger than a nickel. The guides—ultrathin glass or crystal strips deposited on glass—act like

mirrored tunnels to bend laser light around fairly sharp curves. Developed at Bell Labs, the lightguides will be used in laser communication systems.

How do you play pick-up-sticks with thousands of delicate electronic components? The problem for Western Electric engineers was a serious one, for the toothpick-like diodes shown had not only to be picked up, but sorted in a neat and orderly arrangement, all without damaging them.

ing them.



The solution is pictured here. In the top photo, a jumble of diodes have been placed in a container whose walls are strongly magnetized. The diodes hop to it and align themselves with the mag-

netic field, as you can see. An operator then moves a magnetic bin into the container, and the diodes jump into individual notches in the bin, where they are held by tiny magnets. Each bin holds 1,440 diodes (bottom photo). Now the components can be loaded into soldering machines without damaging their delicate leads.

lose an island lately? Oceanographers of Columbia University's Lamont-Doherty Geological Observatory report that the South Atlantic Island of Tristan da Cunha is one mile south and one mile west of where it appears on all modern maps and charts. The voyagers turned up the error—a grave one because of the dangerous shools close by—by means of the Navy's earth satellite navigation system, which enables a special receiver-computer aboard ship to plot a point on the open ocean to an accuracy of 500

Cities may trigger their own snowstorms. Last winter, scientists experimented with cloud-seeding techniques to disrupt the paralyzing snowfalls that plaque Buf-falo, N.Y. and the stretch of the eastern shore of Lake Eric called the snow belt. Their observations led to the tentative theory, as reported by ESSA (the Environmental Science Services Administration) that a big city like Buffalo produces snow much as heavy cloud seeding does. The mechanism might rely on heat rising by convection from the normally warmer city, and even on city-bred dust particles, which could act like seed pellets.

A super sniffer to detect bombs on arithmen has been developed for the Federal Avianta design of the super s

The sniffer is reported to be in use on EUropean carriers. If can detect and some EUropean carriers. If can detect if gives off—even if the vapor forms only one billionth of the air volume the analyzer is sampling. If it picks up a suspicious scent from anywhere in the cargo or passenger areas of the plane, the nose flashes a signal (probably red) to the crew of the cargo or passenger areas of the plane, the nose flashes a signal (probably red) to the crew.

Goff balk in a wind tunnelt That's a long way from the eighteenth green. But it's right on the pin for researchers at Uniroyal, Inc. They're trying to learn more about the flight of a golf ball and what actually happens to the pesky pellet during the five ten-thousandths of a second it takes a club to launch it. The aim, according to Uniroyal, is to "clear up the



old wives' tales, mysteries, and witchcraft," about golf-ball flight and to "understand completely what the golf ball does down to the last decimal point." To this end, engineers have filled a wind tunnel-normally reserved for aerospace research-with golf balls and smoke (the smoke wisps you see in the photo above help indicate lift and dray.

The results so far? A spokesman says, "We have already tested surfaces that give improved performances within the limits set by the USGA." FORE!

A nuclear-age building material, long under development, seems ready to make its weight felt. Called concrete-polymer, the

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Recently, Meyer Steinberg, a chemical engineer there, announced that the concrete-polymer is now being tested for pipelines, pavements, and home con-struction. He predicted that plasticized concrete building blocks might be commercially available in two or three years. Advantages of the new material over conventional concrete include a fourfold increase in tensile strength, almost complete impermeability to water, better bonding to steel, and increased resistance to damage resulting from freezing and Meanwhile, scientists at West Virginia University are working with the Radiation Machinery Corp. to develop plasticized concrete floor tiles. "Our aim." the West Virginians announced, "is to develop an inexpensive floor or wall tile with the beauty and durability of terrazzo."

substance is actually a plastic-impreg-

nated concrete that is hardened by ex-

posure to gamma rays from cobalt 60 or

another source. Most of the basic re-

search on the material has been performed at the Atomic Energy Commis-

sion's Brookhaven National Laboratory.

A two-gas life-support system that could provide an Earth-like atmosphere for manned space stations and spacecraft on lengthy missions is being built for NASA. Mrs. Barbara Greenough, who is directing the research at Lockheed Missiles and Space Co., says the basic unit of the system should now be ready for lab tests. The unit, which supplies enough "atmosphere" for one man, is composed of a stack of nine electrolysis cells. These generate both oxygen and nitrogen by electrolyzing water and hydrazine, a common rocket fuel. If the units prove successful in tests, systems designed to provide atmosphere for crews up to 12 men could be built.

Why supply both oxygen and nitrogen? Many scientists recommend this two-gas combination because diluting the oxygen reduces the fire hazard, and because breathing something that at least resembles air may be an important morale booster for men on long missions.

Lead pollution of the atmosphere is approaching a point of genuine peril in some American cities. That is the conclusion of a geochemist who recently completed a detailed three-year analysis of the lead content of the air over the San Diego area, Dr. Tsaihwa J. Chow of the Scripps Institution of Oceanography at La Jolla, Calif., reported that the atmospheric lead concentration over downtown San Diego on some winter days reached 80 percent of the so-called "safe limit" tentatively proposed by government health agencies. (The concentration runs high on those winter days when a temperature inversion stifles normal atmospheric circulation.) The alarming thing, Dr. Chow noted, is that the lead level has been increasing at the rate of five percent a year. He added that an analysis of the atmospheric lead showed it was identical to the kind of lead used as a gasoline additive to prevent engine knocking.



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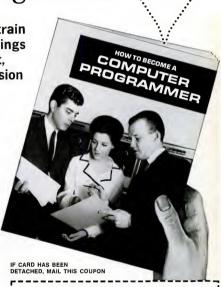
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Blazing a trail for ATVs. The Pennsylvania Department of Forest and Waters has opened a 40-mile ATV track in the Parker Dam State Park. Autos and trucks are prohibited. At the same time, the Department issued rules to protect the park and wildlife so that the land will not be ruined for other recreational purposes. Why not nudge your own state to create such trails, too?



Fire-starting is easy with the Redi-Fire Kit. It has a treated igniter and matches, starts even damp wood in a minute. Skyline Trail, 1355 W. 25 St., San Bernadino, Calif.

Really want to get away from it all? Then you might be interested in trips sponsored by the Wilderness Society, They're staging backpacking tours in Great Smokey Mountains National Park. N.C., in May, as well as in New York's Adirondacks in June and August. In all. they offer 67 trips this year. You can get applications and complete information from the Society's office at 5850 E. Jewell Ave., Denver, Colo. 80222.

For beauty. Winnebago, largest manufacturer of motor homes, recently abandoned billboard advertising because it doesn't want to create eyesores.

Winnebago is also launching a campaign to get all of its dealers to install sanitary disposal stations. There's a big shortage of these dumping stations and the number of self-contained camper units they service is growing fast.

Recreational vehicle equipment corner. A new automatic self-priming pump designed for RVs, which starts without spitting and runs without pulsating, is being offered by The Coleman Co. The model 640P pumps three gallons per minute and has a cut-off to stop pumping after water is exhausted.

Snowmobile need a new track? You might try the FasTrac. This incorporates a spare-tire concept for snowmobile tracks-it's designed so that you can replace links within 20 minutes, even on the trail. It's available for all popular 15-inch tracked snowmobiles. From Molded Products Co., Easthampton, Mass.

New electric level indicator that mounts on the front of your trailer tells you-without leaving the car-if you're level. Your car's brake lights activate the gadget, which registers in your rearview mirror. Available from L. Branvold. 5720 Simpson Ave., N. Hollywood, Calif. 91607, \$10.50.

New Anker tent pegs have a unique design that its maker claims will dig in under strain that pulls ordinary stakes out. They're made by Pathfinder Camping Products Ltd., Burlington, Ont.

Things to write for. Camping Maps USA by Glenn and Dale Rhodes shows you how to get to 12,000 campgrounds and trailer parks with 350,000 sites. It's yours for \$4 from L. Irving, 1 Johnson Rd., Norwalk, Conn. 06851.

The 1970 Recreational Vehicle Year-

book contains a treasure chest of information about RV standards, camping vehicles, and where you can use them. You can get your copy for \$1 from the Recreational Vehicle Institute, 2720 Des Plaines Ave., Des Plaines, Ill. 60018.

A big catch is Sears 1970 Fisherman's Catalog. You can get a copy of this 28page publication by writing Sears, Roebuck and Co., Dept. 139-P, 925 S. Homan Ave., Chicago, Ill, 60607.

Hot stuff. Cooking and fires are always an important part of camping. Here are new items to make this chore easier:

The Grill-Master is a charcoal grill that can be started in five minutes without lighter fluid or other aids. You need only eight sheets of newspaper to get it going. And it will cook a 11/4-inch steak in 20 minutes from the time you ignite it. Available from L. L. Bean, Freeport, Me.

Campers Cook-All bakes, boils, broils, fries, barbecues, smokecooks, or roasts. It can even be used as a space heater. This handy stove, which uses charcoal briquettes or wood, folds into two flat packs for easy carrying. Available from Sam Richards Traders, P.O. Box 456. Bantam, Conn. 06750, for \$20.

Camp laundry. Some problem-solvers are made by the Kendall Fiber Products Co., of Walpole, Mass. These disposable linens are non-woven rayon which can be used for up to a week, then thrown away. Kendall makes twin and double bed sheets and sleeping-bag liners.



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HAND TOOL DIVISION, DRESSER INDUSTRIES, INC. Chicago, Illinois 60604



Slung beneath an aircraft's fuselage, an EROS pod keeps track of the altitude and distance of all other EROS-equipped planes nearby. If it detects the threat of a collision, it activates an illuminated display in the cockpit that tells the pilot what evasive action to take.

Proven in more than 14,000 operational flights, EROS (Eliminate Range O System) has been sponsored by several major U.S. airlines and endorsed by the F.A.A. Approval of the McDonnell-Douglas system's use by commercial airliners is expected later this year.

It works like this: The EROS radio transmitter on a plane continuously broadcasts an identification number and the plane's altitude. Simultaneously, it receives the broadcasts of every other EROS-equipped plane within range. If an EROS unit receives the signal of another plane at the same altitude as itself, it calculates the closing rate of speed of the two planes, and, if collision threatens, sounds a loud beeper and lights up a "climb" or "diwe" arrow on the pilot's rate-of-climb indicator.

What makes EROS remarkable is its ability to repeat complete cycles of communication, interpretation, and display every three seconds for up to 2,000 aircraft. A crystal oscillator, capable of keeping time to within twotenths of a microsecond, makes it possible. Every three seconds a master clock on the ground broadcasts a resvnchronization siznal that resets the time reference of



When collision threatens two aircraft, EROS signals one pilot to climb (left), the other to dive (right). Lighted bars on the bottom of the diving pilot's rate-of-climb indicator warn him to descend slowly because of air traffic below.

every EROS plane. By comparing the arrival time of another plane's signal with its own time reference, an EROS unit determines the other plane's distance away.

To avoid causing a collision, EROS warns the diving pilot if there is an aircraft below him (photo at right, above). EROS also sounds off if two planes at the same altitude fly within 1½ miles of one another, regardless of their closing rate. Robert L. Dilenschneider

Quiet Power for Your Records and Tapes



A revolutionary DC motor may power your next record and tape players. Two semiconductors replace the usual brushes and commutators. Electronic switching, it's claimed, will mean virtually noise-free operation; five times longer life; he end of rumble, wow, and futter. The semiconductors, called "Hall elements," create a voltage across two points when a magnetic field is applied. The effect was discovered by U.S. physicist Edwin H. Hall in 1879, but elements have—until now—been too expensive. Pioneer Electronic Corp., Tokyo, Japan, makes them.

Brushless DC motor (top left) has Hall elements on the outer edges of its windings, a rotor that fits around them. Electronic motor control (bottom left) is a solid-state circuit board. Hall elements (right) come in two ratings.





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"Say, Smokey_"

A clinic on cars by America's most famous mechanic

Each month in Popular Science Smokey Yunick answers questions on cars-family cars, highperformance jobs, hot rods, and racing carsselected from those sent in by readers. Got a problem? Ask Smokey, You'll find the address at the end of the column. Please print your name and address.



I drive my '68, 427 Corvette mostly on the highway, and I'm trying to decide which type of tires to buy. I am tending toward wide-oval radials, rather than Goodyear Polyglas. Which would you recommend, and should I get F70-15 or H70-152

JOEL CHESTER, Brooklyn, N.Y.

You're on the right track with the radials for your needs. They seem to be best when made right, and the only drawback for some people is the rougher ride. F70 and H70 are not far apart. The bigger one steers harder, but holds the road better

When driving a standard-shift car I like to slow down by downshifting. A friend told me that I'll ruin the transmission by this practice. Is this true? Why? Is it better to use the brake?

SUWAT TANTHUWANIT, Boulder Colo.

I think you should listen to your friend, and use the brakes. The production transmission is not tough enough to use for braking. Why isn't it tough enough? Well, to make it so would cost too much to keep the product competitive in price, for no real gain otherwise. A little bit of downshifting won't hurt a thing, particularly on the mountain

Our '64 Rambler American is equipped with a generator. I've seen other 1964's equipped with alternators, and want to put one on mine since it would be better around town. But the people I've asked advise against this. They say it would be too difficult a changeover. After studying the manual I can't find much difference in the main wiring harness. Outside of adding a different regulator and resistor, just how hard would the change be?

JOHN ALLEN, Midland, Mich.

I can't see where this change would be too difficult, keeping certain things in mind. The alternator will have to be mounted correctly, securely, and in line, The major problem is the correct wiring. If the polarity is reversed for even an instant while installing, an alternator will burn out. A new regulator will be required, but it depends on what maker's equipment you get, whether you'll need a resistor, too. Be certain to obtain the correct schematic diagram to match

your selection. And don't make the mistuke of trying to install this change yourself, unless you have had considerable experience. Your best bet is to have this done by a professional auto electrician.

I am rebuilding the bottom end of my Ford 289, which I had previously modified, with a set of Jahns aluminum pistons among other items. This time I'd like to take advantage of a host of available Ford stock goodies by installing a forged-steel Boss 302 crank and a set of 351 heads. Due to the increased stroke. will I be able to keep my 289 pistons? I believe there is some difference between 289 and 302 pistons in deck height and pin height, but my Ford dealer doesn't have the information. Is this a bolt-on operation or will the heads have to be milled to bring the compression ratio back to normal?

RON ARTER, Hanover, Pa.

You've jumped into the biggest can of worms I know of in automotive history -289-302 Ford engines. There are so many combinations that I wonder if anybody really knows what is what about it. My advice is to leave your own engine alone, and wait until you can buy a new model Boss 302 hp with single four-barrel carburetor. You will then have a Holy Terror in one package at a reasonable price.

My 1965 Chevrolet Bel Air with over 60,000 miles on it has been well maintained. It came with permanent antifreeze, with replacement taken care of by a service station. I would like to flush the cooling system and refill with the new Prestone or Zerex antifreeze that contains stop-leak additives and has the permanent feature of the older type. Please give me your opinion.

ROY C. HOFFMAN, Richland, Wash,

As far as I'm concerned, the new products with the stop-leak additive make good sense. Lots of times the ads on new products range from misleading to downright lying, but I have considered these new antifreeze claims carefully and we are trying them now.

I was told that the only thing Ford puts into their diesel trucks is the body and chassis frame, also that they use GM or Cummins engines and Fuller

transmissions. True? And do they, or don't they, make their own rear ends? Please settle this argument.

RANDY DULL, Glen Burnie, Md.

Generally speaking, almost every heavy-truck maker uses front ends, rear ends, transmissions, and engines they didn't build. Except for Mack. which pretty much makes everything in its own trucks. Some other truck makers use transmissions and rear ends of their own make, but not diesel engines. Ford does not make their own heavy diesel engines. transmissions, or rear ends. But neither docs GMC.

I have a '63 Buick Le Sabre with threespeed standard transmission. When the clutch was replaced a few years ago, I asked my dealer if he could install a heavy-duty clutch. He said he could find no plate of heavy duty that would fit; also, that if he could, it would last no longer than the regular clutch, since the only difference would be thicker linings, and the change wouldn't be worth the additional expense. Was he right, or can I find an HD clutch for this model, and would the extra wear justify the expense?

J. J. SAVATINI, Franklynville, N.J.

A heavy-duty plate is available from several manufacturers. One of the best is Velve Touch. It is a metallic type with a very long life, but is somewhat more erratic in response than the standard clutch and also more expensive, Taxis use HD clutches on manual-shift jobs, and many of these are VelveTouch.

Which would be better to install on my '69 Ford 302, a Judson magneto, or capacitive-discharge ignition system? Would I notice an increase in mileage with either? Might the high spark cause damage to plugs?

PAUL BRADLEY, Jacksonville, Fla.

If there is a better ignition system for a 302 Ford than the Autolite Ford transistor system, I don't know about it. I think in comparing mileage difference between standard points and other systems, any claims for better mileage for either are just songs for the birds.

My '68 Firebird 400 with regular suspension bottoms every time I go over the slightest road bump. The frame is all scratched up and the two mufflers dented from this. Both the dealer and the factory representative have told me that this is the way the car rides; that all low cars bottom, and not to load the trunk or carry passengers. Should I change to heavy-duty shocks-even though my mechanic says it won't help?

HOWARD LAKE, Long Beach, N.Y.

You are going to have to do the obvious. Install HD springs and HD shocks. Apparently you operate at high speed on substandard roads and yours is a problem of being short of support.

Got a question on autos? Send it to:

'Say, Smokey-" POPULAR SCIENCE 355 Lexington Ave., New York, N.Y. 10017. Not every question may be used. Questions cannot be answered by individual letters,



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AC SPARK PLUG DIVISION OF GENERAL MOTORS







Lined-up test vehicles (left to right) are the Chevrolet Suburban Carryall, International Travelall D-1000, and Kaiser Jeep Wagoneer



By JAN P. NORBYE
PS Automotive Editor
and JIM DUNNE
PS Detroit Editor
PHOTOS BY DAVE HOUSER

These Wagons Are FAMILY CARS on Truck Chassis

You get up to nine seats and lots of cargo space in a package shorter than many passenger cars

What kind of wagon should you buy? That depends on what you're looking for in a wagon. If you want a maximum of comfort and status, you'll probably get one of the luxury wagons [PS, Mar.]. If you want minimum overall length and maximum useful space, you're likely to pick one of the small buses [PS, May '69].

The wagons here, built on pickuptruck chassis, are for you if you want the space of the small buses combined with the passenger-car-like feeling of the luxury wagons, plus all the convenience obtained by carrying the engine outside the passenger compartment. These wagons offer superior seating, greater ease of entry and exit, and simplified service and maintenance, in comparison with the forwardcontrol wagons.

They're easy to drive. As easy as passenger cars. Anyone who can drive a Chevelle will soon feel pretty much at home in the Suburban, for instance. The controls are the same, and the instrumentation usually better. You also find a variety of familiar fittings and equipment, such as carpeting, coat hooks, courtesy lights, and head-liners-stuff you may not expect in a truck-based vehicle.

Despite the truck-type springs, the ride is pretty good. The long wheel-base helps avoid pitching. Chevy uses coil springs all around on the Suburban, with independent front suspension. The softest ride was found in the Jeep Wagoneer, with I-beam aukes both front and rear, and long leaf springs all around. The International had independent front suspension with torsion bars, and normal leaf springs for the rear axle. There was little to choose between the Suburban and the Travelall with regard to ride comfort.

But we found big differences in



Chevy (center) has rear doors of panel-type truck, while both the International (left) and Jeep (right) have wagon-type tailgates.
32 POPULAR SCIENCE

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Travelall's third seat can be removed and reinstalled without any tools. Simple brack-

ets lock it in place, are easily unlocked But passengers must climb to reach it.



Entry to Chevy's back seat is from curb side only (no back door on left side). Narrow middle seat provides a convenient

corridor for third-seat passengers. Spare wheel, stored inside under a soft black vinyl cover, is easily accessible.



Chevy Suburban is a three-door model (driver's door only, on left), and the vehicle's side windows do not open.



International carries the spare behind a metal panel. Flush interior body sides hide the wheel housings from view.

noise levels. On rough roads, the International was by far the least noisy. At 60 mph on good roads, the Chevy suffered from high-frequency body vibrations, and more of its mechanical noise got through to the passenger compartment than on the Travelall. For full details on noise, see box on page 38.

What about safety? The International body and interior impressed us as being designed more with safety in mind than were the others. Knobs and levers seem to be placed where they would do least damage in an impact. Needless protrusions in the interior have been avoided. While the Travelall has handles modeled on the Chrysler design, on the two others, you find the old-type door handles that are so vulnerable to unintentional operation.

None of them, however, have any provision for rear-window cleaning or defrosting; you are dependent on outside mirrors whenever rain or fog block your view through the rear window. Chevy's "Junior West Coast" mirrors gave the best rear vision. None of the cars have steering locks (as now required on all passenger cars).

The cargo area behind the third seat (or second, in the Wagoneer, which has no third-seat option) is of practical size in all vehicles. Length as given below is measured 12 inches above floor level to compensate for leaning tailgate angle. Height means floor to windowsill.

Width Неіснт LENGTH Chevy 31" 53" 18" Int'l 14" 53" 22" 40" 59" 20" Jeep

With the back seat folded, the Jeep has a cargo-floor length of 641/1 inches. With third seats removed, the Chevy and International have floor lengths of 108 and 99 inches respectively, though the Chevy platform is stepped ahead of the rear axle (75 inches at one level and 33 inches at a lower level).

Chevrolet Suburban Carryall, 'This vehicle is the lowest priced in the group, and has the largest interior dimensions. The body is obviously adapted from a panel truck, with its lack of a left-rear door and its vanstyle rear doors-but the adaptation is successful and practical. A tailgate to lengthen the floor for long cargo is an extra-cost option.

The interior is well laid out, with a convenient passage to and from the third seat-but it's not a nine-seater. There is seating only for seven adults. Both second and third seats can be removed if you need the space-but they are strongly bolted down and you need tools to do the job.

In all routine situations, the wagon

How to really go places this summer.

Biggest hurdle to summer fun is your yard-right? Keeps you hopping all summer. You have to mow it. Weed it. Debug it. Feed it.

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lust a fair-weather friend?

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Choose from our 121/2 gallon Suburban Trail-N-SprayTM or 15, 30 or 50 gallon Matador, Or if you don't own a tractor, check out our regular Suburban model.

Hudson power sprayers. At lawn and garden or implement dealers. Better see them soon, First thing you know it'll be Labor Day and you'll wonder where the summer went again.





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Hudson trailing power sprayers can be used with all makes of garden tractors. Approved for use by these leading manufacturers. Allis-Chalmers, J. I. Case, Ford, International Harseter, Jacobsen, Minneapolis-Molline, Modern Tool & Die Co., Pennsylvania Lawn Products Inc., Simplicity, Speedex, Toro, Western Tool, Wheel Horse.



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Four-wheel drive is standard on the Jeep, and the transfer-case lever, leaning over the transmission tunnel, is easy to reach.



Chevy Suburban carries more instruments than the Impala, Gauges include battery temperature, and oil. Controls are handy



Front-seat center section in Travelall serves also as console storage box with fold-down armrest which lifts to become seat back.

handles exactly like a passenger car When pushed, understeer grows. It proved easily controllable and safe even when brought to its limit in our handling tests. In the low-speed traffic weave, the power-steering pump occasionally suffered momentary catch. The brakes faded seriously, peda pressure rising over 50 percent during warmup. Still, Chevy had the best brakes in this group!

International Travelall 1000-D. There is nothing of a panel truck in this vehicle—the whole body is obviously designed for a wagon, with four door and a lie-down tailgate. Its quietness at all speeds and on all types of roads speaks well for the silence of the engine, the insulation of the running gear, and the quality of the body con struction. The instrument panel was complete and modern, and we particularly liked the fuse box in the glow compartment.

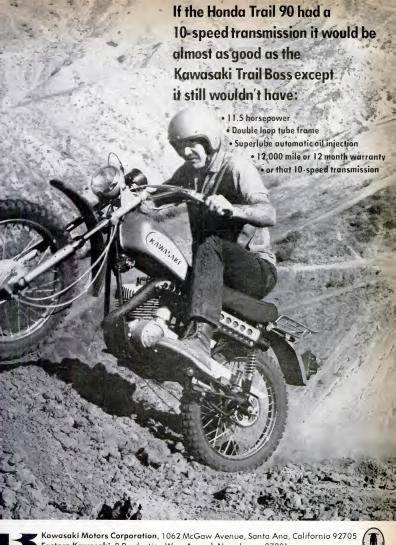
There are pros and cons about the interior layout. You have to climl over the second seat to get to the third. Even though the seat back

International's 304-cubic-inch V-8 is very quiet, almost without vibration, and has tremendous torque. Its service accessibility can't be rated better than fair. The power-steering pump on the left and air-conditioner compressor on the right would get in the way when changing spark pluss. Coil and distributor are easily accessible at the front of the engine for maintenance work.

Jeep Wagoneer is powered by a 350-cubic-inch Buick engine which gives excellent performance with great smoothness. Service accessibility is general-type by good, but the brake booster makes access to the last two plugs on the left side very difficult. The engine was mated to a GM Turbo-HydraMatic transmission which performed faultlessly for us during tests.

36 POPULAR SCIENCE







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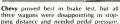
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Jeep was fastest of the three by far in all acceleration tests, averaging 13 seconds to get from a standstill to 60 mph.



Travelall turned in the fastest time in highspeed lane change, always remaining in balance and responding with precision and alacrity—to the driver's commands.

folds, the ladies may not like it. On the other hand, it's a true nine-seater (3+3+3), with the center passenger in front sitting on the padded lid of the console box, using the underside of the folding armrest as a seat back.

We were impressed with the ride and handling, but disappointed in the brakes. They faded badly, and pedal pressure more than doubled during warmup.

Kaiser Jeep Wagoneer. The new face on the Wagoneer celebrates the takeover of Kaiser Jeep by American Motors, but our test wagon had important parts from GM: Buick V-8 and Turbo-HydraMatic transmission. It also stands out by having four-wheel drive as standard (it's optional on International and Chevy), yet its

low profile gives only a slight hint of its off-road mobility. It looks like a big highway-type wagon, a role it also plays very well. It's a true six-seater, but feels smaller and lighter. The tailgate folds down to lengthen cargo space. The spare wheel hangs under the floorboards at the back, difficult to remove and replace.

The variable-ratio steering gave trouble in the handling tests; it is slow response within one half-turn each way from the straight-ahead position kept speeds down. In the brake test, we found a combination of fade and rear wheel locking, giving this ear the longest stopping distance in the group Conclusions.

We're unable to pick a "winner' here. Your choice must be directed by

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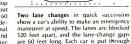
Dunne and Norbve measure leep's stopping distance from 60 mph: 201 feet 5 inches. All-time record for PS tests is held by 1970 Ford Torino, at 126 feet 8 inches.

your purse and your purpose. Study the specs and the test results. And if you're going to carry heavy loads or pull a trailer, order the biggest, heaviest-duty brakes available! Disk brakes are not yet optional for this class of vehicle. In no case would we recommend six-cylinder engines in these wagons. The economy gains are questionable, and should you make use of the load capacity, you would find six-cylinder power inadequate. If the fuel economy for these V8s looks poor to you, remember that averages include performance testing.

How PS tests cars—and what the tests show

Our brake test shows a car's ability to stop on a straight line from 60 mph, without locking any wheels, after 10 stops from 60 mph at one-minute intervals with 1/2 g deceleration (normal quick stop). The final stop is made in a 12-foot-wide lane and stopping distance is measured. Excessive pedal pressure indicates fading brakes. Excessive distance indicates fade, locking, or both in combination.

Our 0-60 mph acceleration test shows a car's ability to reach cruising speed from stand-still. The 0-80 mph test shows its high-speed power reserve. The 25-70 mph test simulates highway merging situation. Cars with automatic transmission make these tests in Drive.



imum has been established.

The low-speed emergency-maneuver test consists of snaking a car as fast as possible through pylons spaced 48 feet apart. In both handling tests, times are clocked by two stopwatches, then converted to mpli.

the test at increasing speed until its max-



	CHEVROI
DIMENSIONS (inches)	Suburban 7.0
A1 Ground clearance	43.25
A2 Front leg room (max.)	39.0
A3 Front head room	38.0
A4 Middle-seat head room	42.0
A5 Middle-seat leg room	
A6 Third-seat head room	37.0 37.0
A7 Third-seat leg room	
A8 Wheelbase	127.0
A9 Height	69.8
B1 Length	207.75
B2 Width	78.9
B3 Front track	63.0
B4 Rear track B5 Front hip room	61.0
B5 Front hip room	60.0
B6 Middle seat hip room	44.5
B7 Third-seat hip room	44.5
SPECIFICATIONS	
Engine type	OHV V-8
Bore × stroke	3.875×3
Displacement	307 cu. ir
Compression ratio	9.0:1
Carburetion	One 2-bar
Power @ rpm	200 @ 4.
Torque @ rpm	300 @ 2.
Transmission	T-HydraN
Axle ratio	3.07:1
Tires	Uniroyal
Tire size	H78-15
Turning diameter	47 ft. 6 in
Turns, Tock to lock	4.2

Turns, loc Brakes Fuel tank

Fuel tank
Curb weight
TEST RESULTS
Acceleration 0-60 mph
Acceleration 0-80 mph
Acceleration 2-70 mph
Braking distance 60-0 mp
Pedal pressure (final stop
Max. speed—lane change
Max. speed—traffic weav
Average fuel mileage

Average fuel mileag Price (basic)

Price (as tested)

	44.5
	OHV V-8 3.875 × 3.25 in. 307 cu. in. 9.0:1 0ne 2-barrel 200 @ 4,600 300 @ 2,400 T-HydraMatic 3.07:1 Uniroyal H78-15 47 ft. 6 in 4.2 All drums 21 gal. 3.836 lbs
h o)	17.6 sec. 33.9 sec. 18.1 sec. 177 ft. 10 in 200: lbs

INTERNATIONAL Travelall	KAISER JE Wagoneer 7.6
7.3 41.0	43.0
38.25 38.0	36.5 37.0
38.0 34.0	39.0
39.75 131.0	110.0
69.0 210.0	64.0 183.65
77.6	75.6
61.4 61.04	57.0 57.0
60.0	58.0

60.5

OHV V-8 3.875 × 3.21 in. 304 cu. in. 8.19:1 One 2-barrel 193 @ 4,400 273 @ 2,800 Borg-Warner 3.07:1 Condition

4.05 All drums

ft.

57.0 58.0 55.0
OHV V-8 3.80 × 3.85 is 350 cu. in. 90.11 One 2-barrel 230 @ 4,400 350 @ 2,400 T-HydraMati 3.54:1 Goodyear 8.55:15 44 ft. 5 in. 4.0 All drums 20 gal. 3,707 lbs.
13.0 sec. 28.8 sec. 14.1 sec.

ISER JEEF

40 POPULAR SCIENCE



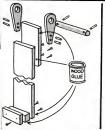


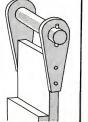




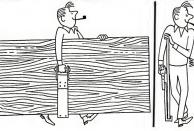














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BOATING New Water Bike—Hang a Motor on It and Go!

Handles like a motorcycle, say the makers of Hydro-Cycle. You steer with handlebars, vary speed with a twist-grip throttle that shuts off if you let go. A lever on the side shifts from neutral to forward/reverse.

Made of foam-filled fiberglass, the new sports craft weighs 250 pounds. measures nine by five feet. Its speed depends on your power plant-7-35hp, outboards are recommended. The hull, without motor, sells for under \$700 and comes in eight colors from Hydro-Cycle, Inc., 215 E. Alma Ave., San Jose, Calif. 95112.

> Powered by a 35-hp. outboard, the new Hydro-Cycle hits speeds of up to 35 mph with two in the saddle, two more riding on skis behind.



For Cruisers: All-in-One Electronic Command Center



Scope for optional radar fits in a slick tilt-out cabinet mounted under console.



150-watt AM radiophone, like other command center units, slides out for servicing.

Command bridge of a 55-foot Chris-Craft has automatic direction finder, automatic pilot, and radio-telephone to left of the steering wheel. Two throttles and compass are in center; port and starboard engine gauges and switches are located at the right.

When a Chris-Craft skipper takes the wheel of his new cruiser, he'll find an orderly array of electronic gear, controls, and gauges within reach. A familiar sight in aircraft and automobiles, it's a first for boats, whose bridges are usually cluttered with a variety of boxes and panels added after launching.

Chris-Craft designers worked with Raytheon electronics experts to develop a line-up of integrated units that are built into the boat at the factory. They're miniaturized as much as possible with solid-state devices and integrated circuits, placed for convenient use, and made compatible with one another to avoid interference.

On 35- to 45-foot cruisers, these built-ins include a depth sounder, loud hailer, and 100-watt AM radiophone. Larger boats come equipped as shown below. Both have space for later additions if you want them.



MAY 7, 1945

Where were you on that memorable day? Everyone has his memories—his souvenirs. And each performed his individual bit of heroism during that last great war. It was a proud victory for all.

Now, as a tribute to American courage and principle, Colt's is offering a limited issue of the Colt .45, commemorating the 25th anniversary of that European victory.

A decorative gun, its slide is engraved with oak leaves and the names of historic engagements. Finished in gleaming nickel, this outstanding Colt's Commemorative features exotic Birdseye Maple grips. Packaged in a solid oak presentation case with 7 deactivated, nickel-plated cartridges.

Included is a fully illustrated, 640-page special Colt's edition of the American Heritage Picture History of World War II.

The entire package is available now at your Colt's Registered Dealer. Also available—a Pacific Theater issue. Ask about it. Colt's Small Arms Division, Hartford, Connecticut 06102.





New Boost for Turbocharged Cars

By IERRY SLONIGER

Today, turbocharging is commonplace. It is practically standard for long-haul diesel trucks to carry a turbocharger. Piston-engined aircraft rely on chargers in the reach for altitude. And a V8 with an exhaust-driven blower won at Indianapolis last year.

Yet Detroit has rejected the whole concept of turbocharged cars. Chevrolet and Oldsmobile tried them in '62, but the option disappeared in short order.

Enter Michael May, a Swiss genius, who contends he knows where GM went wrong. In his own words: "We have a basically new and different regulation system: Today he runs Turbo May Inc., making blowers in a refurbished cloister south of Stuttgart. The Turbo May unit costs around \$800, but price could be brought down to \$200 with larger production runs. That's pretty reasonable for a turbine that lifts the 108-hp 140-cubic-inch Ford V6 to 180 hp with little increase in fuel consumption, greater tractability, and no internal modifications whatsoever. As an add-on kit, his blower may be fitted in under six hours, including minor chassis tweaks and harder disk brake pads.

May's success story began when he combined with Germany's largest Ford dealer to produce a turbocharged version of the Capri. Hundreds have been sold. But officially, the Ford organization is against the Turbo May.

Seven turbocharged Fords were found good by their own test engineers. Still, Ford brass refused to make the kit optional. They won't even guarantee the paint job once the Turbo May unit is installed! May guarantees his own parts fully. The basic turbine is an Eberspächer



The turbocharger is fitted on the right-hand side of the Ford V6 engine. Fresh air goes through a coarse filter before it is fed under pressure to the air cleaner, then into the carburetor.



How does it work?

Turbocharging is a process that uses an exhaust-gas-driven turbine to drive a compressor for blower). The kinetic energy of the exhaust gas—which would otherwise be wasted—is harnessed to force more air through the intake system, and into the cylinders. Normally, both turbine and blower are mounted on the same shalt, as shown here.

diesel loader adapted to the Ford V6. May chose this engine for its sturdy, short crankshaft and compact cylinder heads.

No long intake tract. Ford's stock two-barrel carburetor is largely untouched, right down to leaving its automatic choke in action, though it is fed by a high-pressure fuel pump. May left the inlet manifold alone—"the reason for the GM failure on turbocharged Corvairs and F-85's [Continued on Pase 139]



Sears sized up the weather and discovered two new ways to camp dry and sleep tight.

Nothing ruins a camping trip faster than cold, wet weather. Sears didn't want anyone to

suffer through it. So they worked on ways to beat the weather. They started with a new kind of tent. One with a 100% water-

of tent. One with a 100% waterproof floor. Nylon and vinyl welded together, so there's not a seam or stitch to leak.

Then the floor was run six inches up the sides of the tent. Even if the tent sits in the middle of a puddle, not a drop gets inside.

For the tent fabric, Sears used a rugged cotton drill with a special finish that sheds water like a duck,

It's the perfect tent for family camping. 10x16 feet of living space. And whatever the weather, your family camps dry. Sleeps well, too, because Sears had a great idea for sleeping bags. They went to the U.S. Weather Bureau to find out the different temperatures you could expect across the country.

Then Sears had bags made to match them. One for warm nights. One for 20° to 50°. Another for below 20°. And the bags are made in three sizes—including king.

Tomorrow, check out all the great camping equipment at the Sears Sports Center in a Sears, Roebuck and Co. store. Or the Catalog.



where the new ideas are

MEMBER SEARS SPORTS ADVISORY STAFF

This check mark and signature certify this tent and sleeping bag met the standards set by Ted Williams,

Chairman of the Sears Sports Advisory Staff, and were personally tested and approved by Sir Edmund Hillary, first man up Mt. Everest, and Sears Sports Staff Advisor,

This Cool Night Bag looks as good as it sleeps. It's made with light new fabrics in bright new colors.



New Ideas from the Inventors

ILLUSTRATIONS BY DANA RASMUSSEN



Portable dock rolls in or out. Towed or trucked to the shore, this recently patented dock would roll out quickly to bout-mooring depth. Walkway planks would be supported by hinged channels sized so longer outer sections could fold square around inner ones. The walkway would be helped in or out by a detachable float. The dock would be secured by vertical posts.



Phone timer limits calls. Fitted between a phone's handset and cradle, this timer for talky telephoners would start countries when the receiver was lifted, cut the connection after a selected interval (or sound a time's-up signal). Replacing the handset would reset the timer.



Doorstop helps pull boots. Screwed to a door or behind it, this rubber-covered, J-shaped bar would serve both to bumper the door and to make it easier to remove boots or galoshes. It's intended to get boots off at the door instead of inside, let callers arrive with cleaner hands and feet.



Bucket saw digs hard earth. Extended from the bottom of an excavator bucket, this bolted-on, saw-toothed plate could speed digging operations (and lessen jackhammer noise) by cutting into hard or frozen ground. A spike at the back would break up earth clots between kerf.



Stand eases work fatigue. Secured by your own weight on a padded foot-rest, "leaner" would let you rest your back against a cushioned adjustable support. Less restricting than a sitdown stool, the stand keeps you close to your work but free to move fast. For use by dentists, others who spend hours standing in one place,



Panels adjust sails. Louvered like a Venetian blind, the curved, rigid panels of this sail could expose controlled amounts of "canvas" for any wind. Adjustment is said to be faster than trimming conventional sails, Small panels at the luff edges would deflect air from the windward side to produce negative pressure on the convex side.

The following patents have been issued on these inventions: Roll-out dock— No. 3,397,546 to L. H. and W. C. Eisert. Crookston, Minn.; Phone timer— No. 3,472,566 to R. R. Simmons, Washington, D. C.; Boot puller-No. 3,404,817 to H. Stephens, Winnipeg, Manitoba, Can.; Bucket saw—No. day, Boyomon, Puerto Rico; Louvered sail-No. 3.403,653 to H. Bush, Livonia, Mich. Copies of patents may be ordered, by number, from the Commissioner of Potents, Washington, D. C. 20231, at 50 cents each. To write to an inventor, address him (by name and patent number) in care of the Commissioner.

The 1970 GRAVELY Riding Tractor.

We'd sell even more of them if the old Gravelys didn't last so long.



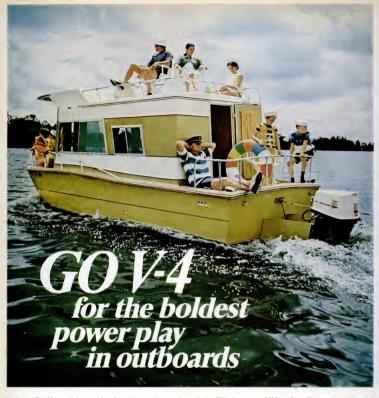
That old tractor is 15 years old and still going strong. Which should come as no surprise to you, if you've ever talked to a Gravely owner. We sell many of our new tractors because of word-of-mouth praise by owners who know how long their old Gravelys last.

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Both the Sea-Horse 115 and 85 deliver high excitement in a sleek, low profile. Their efficient V-4 powerheads combine quick acceleration with the kind of staying power you could only get from a Johnson. Underneath our low-down lids, you'll find solid state Power/Pulse ignition and a pair of two barrel carbs. Underwater. our V's feature a low-drag, one-piece gearcase. And at the business end of all this go-power, you can now match the prop to your boat with a choice of standard propellers and 3 optional high performance bronze wheels. To give you full play over all this power and performance, the 115 and 85 both feature Johnson's exclusive

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Ford's New SMOG-FREE ENGINE

The inside story on how Ford developed the stratified-charge fuel-injection engine and what it may mean to cars of the future

By IIM DUNNE / PS Detroit Editor

f you have been following the development of smog-free piston engines as reported by POPULAR SCIENCE, you are probably well aware that a systems approach is necessary. You can't just buy a little can of magic potion or a miracle gadget and make your car smog-free.

Ford Motor Co. is now testing several of these systems approaches, some in its own research department. some in the Inter-Industry Emission Control Program [PS, Apr. '70], and some in course of development under defense contracts. This one falls in the last category. Two prototypes have been built and are now undergoing tests, one at Ford's proving grounds, the other in the hands of the U. S. Army Automotive Tank Command. If the Army approves the prototype, the smog-free light military vehicle could be in production within 12 months.

A combination of systems. No one at Ford mentions the word "breakthrough" in the same breath with this project. It has been a carefully planned study, with improvements resulting from painstaking attention to detail rather than from one sudden discovery. Ford's smog-free engine is not a new engine concept, but a carefully worked-out combination of systems applied to an existing pro-duction engine. The systems that make the engine smog-free are:

 Fuel injection, for uniform air/ fuel mixture in all cylinders.

· Metering of air and fuel, for air/fuel ratios of 18:1 or leaner. Stratified-charge combustion, for

complete burning of the mixture. Exhaust gas recirculation, to combat emissions of oxides of nitrogen (which increase when hydrocar-

bons and carbon monoxide elements are most efficiently burned). Continued



The four-cylinder stratified-charge fuelinjection engine is basically the standard M-151 (Mutt) power plant, outfitted with a batch of experimental hardware that cuts emissions to practically zero, adds power, and reduces fuel consumption.

The stratified-charge research program at Ford is headed by A. C. Sampietro, formerly of Sunbeam-Talbot, Healey, and Kaiser Jeep, Here he explains the process.

MAY 1970 | 55

Complete combustion is achieved by a fuel injection system, precisely

Stratified-charge fuel injection is the most sophisticated form of delivering fuel into the engine. The nozzle sprays gasoline under very high pressure into the combustion chamber itself (most commercial fuel injection systems have low-pressure jet nozzles positioned in the port area, ahead of the intake valve). Low-pressure injection cannot be used for direct delivery into the cylinders because of the air pressure buildup during compression. The stratification of the fuel charge is designed to achieve fuller and faster vaporization than is possible with one-hole nozzles.

Whopping power increase. Although Ford's IIEC packages achieve smog-free operation at the penalty of a 20 to 30 percent power loss, the stratified-tharge engine produces a 25 percent power increase plus a 10 percent improvement in fuel economy. The base-line figures represent the current Mutt engine, as used in the successor to the World-War II Jeep.

Converting the Mutt engine to stratified charge (SC) was a simple matter. Ford had already proven the SC system on one-cylinder engines in the laboratory, and even outfitted a big Lincoln V8 [PS, July '68] to prove its findings. These, by any measure, were amazing.

Super-efficient-but expensive. For years, engine designers have been fascinated by the efficiency of SC systems. They perform superbly: They deliver whopping fuel economy gains (up to 40 percent more mileage in one test); burn fuel so efficiently

that two of the three major emission pollutants are reduced to insignificance; run on regular-grade fuel; start without the aid of a choke in the coldest weather; use the same major parts as present engines without a carburetor; and do all this with no loss in engine power.

But up to now, the high cost of SC killed whatever chance the auto companies had for producing it in volume. What makes SC so attractive now? Simply the stringent new federal laws regulating pollutants.

Passenger-car engines of the future may use expensive and power-robbing catalytic converters, afterburners, and air pumps to meet emission standards. Ford SC specialists, under the direction of A. C. Sampietro, manager of Power Train Research, can accomplish the same results with the basic SC components-fuel injection, an oddly shaped combustion chamber, special spark plugs, and the control equipment needed to make these parts work. Weighing the cost of one against the other, it is estimated that the SC system will be cheaper by far.

One problem bugged them. Briefly, stratified charge means precision burning. The compact SC combustion chamber is shaped to burn fuel as completely as possible. It takes advantage of the precise distribution of fuel by injectors, and the ignition of fuel by injectors, and the ignition of fuel at the center of the combustion chamber by a new and unique spark plug. It was adapted to the Mutt engine with little trouble. But one problem remained. The NO_x emissions were unacceptably large

because of the high temperatures and the high (up to 25:1) air/fuel ratios of the super-efficient burning.

To combat the NO_x emissions. Aladar Simko (who actively supervised the Mutt adaptation at Ford), actually had to cut back the efficiency of the SC. Simko revised the SC system so that burning in the combustion chamber was divided into two stages: the first one rich-with air/fuel ratios as low as 5:1 to eliminate some NOx; the second one a lean 18:1, where burning efficiency was ideal. Both stages occurred during the same power stroke of the piston, and were essentially one continuous burn that quickly changed from rich to lean. But that solved only one part of the NO_x problem. Simko also had to lower the high temperatures in the combustion chamber. down to 3,400 degrees. He accomplished this by recirculating part of the exhaust gases back into the intake manifold to dilute the intake air, thus cutting down the intensity of combustion. These recirculated exhaust gases make up 10 to 15 percent of the intake air. With the lower temperature, the NO_x emissions all but disappeared.

Compare the figures. Here is how the Ford-altered Jeep engine stacks up against the government's estimated emission standards and the present Mutt engine. In grams per mile:

	sc	Carb	'72	Est. '74	
	Mutt	Mutt	Stand.	Stand.	
HC	1.5	5.45	4.9	3.3	
CO	15.0	77.9	40.0	40.0	
NIO.	10	0.10	4 5	0.0	



Aladar Simko conducted basic research on the stratified-charge concept with this single-cylinder engine mounted on a dynamometer. Here he is monitoring the fuel injection system.



Fuel injector (left) and special spark plug are held in approximately the same position they have in the stratified-charge Mutt engine.



Main parts of the fuel injection distributor are precision-made at high cost. The pump delivers fuel at 550 psi (low pressure compared with 4,000-16,000 psi diesel pumps).

ontrolling air/fuel ratios

Moreover, Simko found that the Mutt engine could be boosted to a leak output of 73 hp from the present 8.5, a 25-percent gain in output intend of a loss.

The 10-percent gain in fuel economy is intrinsic and can be expected rom any engine equipped with SC.

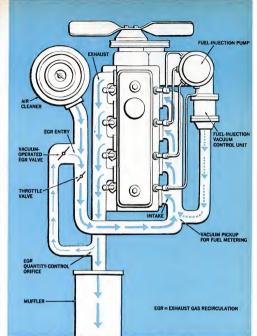
Although Ford will not release any

Attnough Ford win not release any ost figures for the modified engine, xperts estimate that the changes vould add less than \$100 to the base futt engine. On the other hand, roposed smog-control units that inlude afterburners, catalytic muffler, ir pumps, and exhaust gas recircuating systems probably top that figure by a significant amount.

Stratified-charge parts add on 25 sounds to the engine weight, when the arts are handmade. The production omponents could cut this weight in alf, and would end up lighter than dd-on smog-control parts.

Wider markets aheadf. Ford is a narketing as well as engineering or-anization, and sees wider markets or the Mutt engine than just the 4.151 military vehicle. Post Office chicles could use the engine, too tight now, the PO has 30,000 veicles that use the Mutt engine. In he future, these, too, will be able to se the SC Mutt design—a giant tride in the antipollution drive.

How soon will the SC Mutt be eady for production? American losch is now engineering design hanges to make the highly critical uel injection system easier to prouce. The complete engine could robably go into full production withn 12 months.

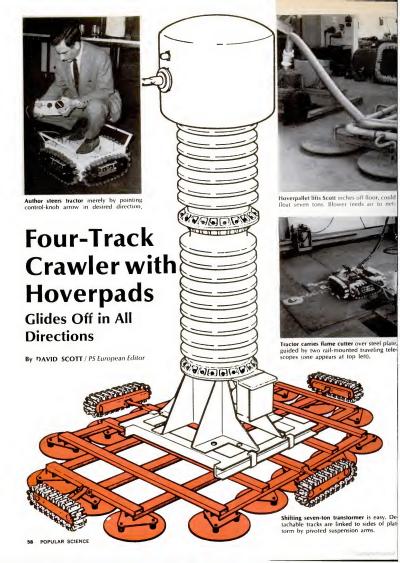




his valve in the air intake chamber controls the air/fuel titos by carefully metering air volume. The mixture is ept constantly lean—18 parts air to one part gasoline, or laner. This assures complete combustion.



Pump assembly contains all the major fuel and electrical distributor components. The shiny cylinder branching off from the injection pump is connected to an intake manifold vacuum pickup and meters the quantity of fuel to be injected.

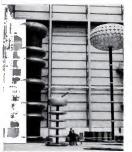




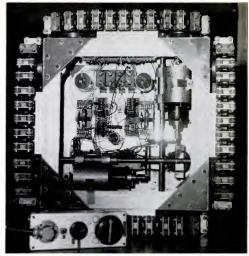
work of pipes and into eight pads with segmented skirts (like those at rear).



Cycle-type track chains have spring suspension, flanged links bearing U-section channels with transverse nylon rollers.



Electrical test laboratory houses giant equipment—including 70-foot transformer—that must be maneuvered remotely.



Drive motors and electronic circuits nestle inside chassis. Input split at control box

feeds five-watt servomotors, which drive two pairs of tracks through gears.

Want to maneuver a seven-ton load in no space at all? This strange vehicle combines a unique drive with a cushion of air to accomplish the seemingly impossible

C an you imagine a vehicle that has no steering action and can't turn, yet can travel forward, sideways, or at any angle in between?

Think again. I had to change my mind at the research laboratory of British Oxygen Corp., in London, where 39-year-old Dr. Brian Doxey showed me his fantastic brainchild.

This gadget is an omnidirectional crawler-tractor with two pairs of identical tracks flanking the four sides of the square chassis. Each pair is powered by its own electric motor, and the four tracks always bear against the running surface.

Real crazy? Not at all. There's an ingenious wrinkle: The linked shoes on each track have small transverse rollers that make the actual contact with the surface. When one pair of opposed tracks (let's call them "X") is driven, their rollers are thrust at right angles to their axes, and thus provide forward traction.

Meanwhile, when the other two ("Y") tracks are idle, their rollers freewheel, for the direction of movement is at right angles to their axes. If you switch over the drive so the Y tracks are powered and the X ones are stationary, presto—the tractor crabs sideways on the fixed rollers.

Drive all four tracks at once and the result is amazing. The crawler moves at an oblique angle, but without turning. What happens is that all the rollers are propelling the machine while rolling sideways at the same time.

Hard to follow? Remember that with a conventional crawler, the lower flat stretch on each loop of track is actually stationary in relation to the ground. Travel results from one sprocket laying down track from the front of the loop while the other sprocket is picking it up at the rear.

With Dr. Doxey's omnidirectional machine the rollers can both push and rotate without any scraping or "scrub." He demonstrated this action by placing a pencil on the lab floor end-on against one of the little rollers. The pencil was merely pushed dead-

[Continued on page 134]

Fighting the "CAT" That Threatens You



You're flying in cloudless weather. Suddenly, your plane plummets 2,000 feet. Why? The pilot of a research sailplane explores clear-air turbulence

By CAPT. KIMBALL J. SCRIBNER

Pan American World Airways captain of jumbo Boeing 747s, and a champion glider pilot, the author has honorary degree of doctor of aeronautical science.

A concerted national attack has just been announced against an invisible peril to airliners and their passengers —clear-air turbulence, known as CAT for short.

The U.S. Departments of Commerce, Defense, and Transportation, and the National Aeronautics and Space Administration, are joining in a five-year anti-CAT program. Objectives include airborne instruments for remote detection of CAT, and techniques to predict CAT areas for preflight planning. The Weather Bureau is creating a national CAT-forecasting service to distribute predictions by facsimile every six hours.

When the "FASTEN SEAT BELTS" sign flashes on unexpectedly, and your airliner tosses like a ship in a heavy sea—though you can't see a single cloud from your windowyour craft has "hit the CAT." Striking out of a clear blue sky, CAT may range in severity from an uncomfortable nuisance—spilling your coffee or cocktail—to a killer.

At its worst, CAT has been known to tear a wing from an airplane, or send an airplane diving out of control to a crash. CAT was implicated in 11 civilian-aircraft crashes of 1969, two of them fatal.

What causes CAT? Commonly, CAT appears to consist of swirling eddies along the borders of an air current, sometimes the jet stream, moving at a different speed or in a different direction from surrounding air.

Contrary to earlier belief, CAT is

not limited to the lower atmosphere High-flying U-2s have found CAT throughout the stratosphere, including the high levels where coming su personic transports will fly.

Typically, a region of CAT is a thin horizontal layer—perhaps 50 to 100 miles long, 10 or 20 miles wide, and some 1,500 to 2,000 feet thick.

The best of forecasts can hardly hope to pinpoint these localized and shifting "patches" of CAT precisely What an airline pilot needs more is ar airborne instrument for remote detection of CAT in flight, in time to avoic it or to slacken speed before slamming into it. Just such a CAT-detecting in strument is on the way.

Hunting CAT in a glider. At the controls of a unique research glider, I had a part in a recent study of CAT that successfully tested a prototype warning device for pilots.

The two-year CAT project was ar unprecedented venture of the Explorers Club of New York, often a sponsoi of exploratory expeditions to remote parts of the world. To delve into CAT it formed a non-profit affiliate, the Explorers Research Corporation. Namee president was George R. Wallace, as industrialist of Fitchburg, Mass., and a noted philanthropist, who funded the entire CAT program. I was appointed vice president and director of aviation research.





Flying laboratory for CAT study was the engineless saiplane "Explorer" towed he airplane to site, and pictured at lett wit author piloting and George R. Wallace a passenger Smoke-releasing gear on boar made air currents visible. After close ca with leak of acid smoke in cockpit, Cap Scribner donned oxygen mask, as abow before closing cockpit canopy for flight.

rom a Clear Blue Sky

For a flying laboratory, a sailplane high-performance glider-was —a chosen in preference to a powered aircraft. Like a leaf borne on the wind. the glider would become a part of a turbulent air mass-moving freely with gusts and eddies, rather than risking destruction by bucking through them.

Built to order for the project at Elmira, N.Y., by the Schweizer Aircraft Corp. was the all-metal sailplane "Explorer." A craft of 57-foot wing span. white with blue and red trim, it could soar to 50,000 feet. Its fine glide ratio of about 30-to-one meant that in still air it could sail from a one-mile height to a landing 30 miles away. It was designed to endure gust-load factors exceeding nine g's. (More than 0.3 g is classified as CAT.)

The "Explorer" was a two-seater, though big enough for three; it carried just its pilot and, sometimes, an observer. This left room and weight capacity for elaborate navigating and

data-recording equipment.

"Mountain waves." Where do you take a flying laboratory to look for CAT? You might seek its random patches over most of the country in vain. But on the lee side of high mountains, you can often find one form of CAT—the complex patterns of updrafts, downdrafts, and rolling air known as "mountain waves." Though dangerous to powered aircraft, they offered the sailplane an ideal CAT hunting ground.

Beginning in 1967, I piloted the "Explorer" on a series of flights at Mt. Washington, N.H., the highest mountain in the Northeast. Then it was flown above the Rocky Mountains of the Continental Divide at Boulder, Colo. Winds up to 250 mph, at Mt.

Washington, are the strongest measured on the continent.

Being engineless, the "Explorer" was towed to location by a propellerdriven airplane from a convenient airport. A starting point for Mt. Washington flights was at Fryeburg, Me., about 20 miles away. As we approached the 6,288-foot peak, high enticular clouds showed the formaion of a mountain wave. The "Explorer" bobbed like a cork on its towine. At about 10,000 feet, I pulled a ed knob on the instrument panel

that freed the sailplane, and banked away to gain altitude in rising air

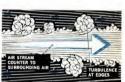
A flying weather vane, Accelerometers aboard the "Explorer" recorded its every motion as it careened and quivered in eddies of air. Thus the sailplane itself became a sort of weather vane to reveal their behavior.

The "Explorer" had a way of enabling invisible CAT to be seen and photographed. A cylinder secured to the cockpit floor behind me held chlorosulfonic acid, which makes dense white smoke on contact with air, and is used in a military smokescreen agent. Stored under 10 pounds' pressure, the chemical was released under my control-through a tube extending two feet beyond the tail of the sailplane, to keep the corrosive acid from touching it. As the "Explorer" encountered turbulence, it ejected a smoke trail. An observer in the tow plane made 16-mm color movies of the swirling smoke cloud.

Some of my wild rides through mountain-wave turbulence, lurching on upward gusts and plummeting in downdrafts, were fantastic. At times the sailplane was standing on a wingtip-and often the shuddering control panel made instruments hard to read. But I had my most exciting experience during a routine tow to Mt. Washington, in November of 1967.

"Acid in the cockpit!" As we crossed a lake at 1,000 feet, not long after leaving Fryeburg, I detected the raw penetrating odor of the smokemaking acid. A leak! At its 10-pound pressure, I knew, the corrosive smoke would quickly fill the whole cockpit. There wouldn't be time to get my oxygen mask on and working before I was blinded, if not suffocated, by the acid.

I shouted into the hand mike, "Acid in the cockpit-releasing!" In turn I yanked at the towline-release knob.



CAT typically occurs along the boundaries of air stream moving at a different speed. or in different direction, from surrounding air, and can be dangerous to airliners.



'Mountain waves" are a form of CAT on lee sides of peaks. They offered good CAT hunting grounds for sailplane "Explorer," which rode currents like leaf in a wind,



CAT has claws. It ripped away most of tail fin (broken outline) of this Air Force B-52 Superfortress, pictured as craft limped home to rudderless but safe landing,

"Most promising and furthest along" of airborne instruments to warn of CAT

the canopy's lock, and its release handle. The canopy flew open, and the 120-mile wind in my face blew the smoke away from me. Turning the sailplane, I saw I hade nough altitude to get back to the airport. But I had to hold the canopy open, and I didn't seem to have enough hands. My knees had to take the stick while I retrimmed the "Explorer" to keep from diving—and, again, when I operated the "spoiler" control to land.

Waiting on the runway were the ground crew, with a cylinder of neutralizing agent to squirt on me and offset the acid. I rolled out into their

The leak was soon fixed. The aft cockpit was cleaned up where the acid had eaten paint away—and we were off again looking for CAT. Henceforth the plumbing was rechecked before each flight—and I wore my oxygen mask with oxygen on as soon as the canopy was closed for takeoff.

An infrared CAT detector. Most novel of the sailplane's instruments was a prototype infrared CAT-warning device, developed for the Air Force Cambridge Research Laboratories by the Barnes Engineering Co. of Stamford, Com. In effect a thermometer with a bulb adjustable in length from several thousand feet to 40 miles long, it took the air's temperature miles ahead of the sailplane—and compared this with the temperature of nearby air.

Control-panel indicators showed when near and far air differed in temperature—and the temperature "discontinuity" was recorded on tape automatically, together with time and g-loads, as the sailplane entered an area of turbulence.

It had been assumed, but never proven, that an abrupt change in air temperature along a level line of sight ahead would betray a CAT region. The "Explorer" proved it.

When the flying laboratory encountered CAT, it withdrew, trained the temperature sensor on where CAT was positively known to be, and flew slowly back into it. A sharp air-temperature change of 2° C to 5° C (3.6° F to 9° F) was a telltale sign of CAT. The infrared sensor could detect this change 25 miles away.

In a jetliner speeding at 600 mph, this would give a pilot nearly three minutes to flash the seat-belt signal and make adjustments to ease an encounter with CAT—or take evasive action, by changing altitude or heading, to avoid it altogether.

A camera photographed the sailplane's nose against the horizon to show its pitch while readings were taken. The CAT detector was found to give false alarms if it was looking downward toward naturally warmer air, or upward into colder air; its line of sight had to be kept level, whatever the attitude of the craft it was in. Incorporating a tilting mirror, servodriven by an airliner's vertical gyro, was the answer.

By early 1969, after more than 150 "Explorer" flights, the CAT project had all the data it wanted.

Explorers Research then presented the Saviplane to the Environmental Science Services Administration. ESSA is using it at Boulder, Colo., in a pioneer survey of the amounts of dustlike and gaseous pollutants in the stratosphere-against which any future increase of contamination by supersonic aircraft and other high-

flying vehicles can be gauged.
Meanwhile, the work on CAT-detecting instruments goes on. Besides the infrared device the "Explorer" tested, the new Federal CAT program is looking into other detectors, including radar and laser devices.

Can "angels" herald CAT? Radar echoes from raindrops have warned of distant storms since 1941. CAT offers a less tangible target. But it has lately been identified as one of two causes of "angels"—long-mysterious radar echoes observed with no known targets in range.

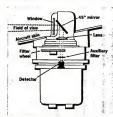
"Dot" or point-source "angels" have been traced to flying insects; a trial at Wallops Island, Va., showed that a bumblebee released from an aircraft could be tracked by powerful radar at a 10-mile distance. More diffuse "angel" echoes, it was suspected, came from unevenly refractive air layers—characteristic of CAT.



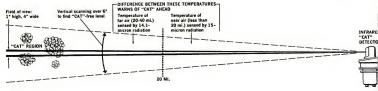
Sensor head of Barnes infrared CAT detector peers ahead of craft through window (black disk) at smaller end.



For current airline trials, CAT detector is mounted atop jetliner. Projecting window (with fairing behind) is seen at the lower left of the photograph above.



How infrared CAT detector works is shown by design diagram, above, and drawing of operating scheme below.



new infrared detector

In 1967, these "angels" were first pinned positively to CAT by Air Force and other radar researchers at Wallops Island. Aircraft went aloft and actually found CAT at the places from which the microwave echoes were simultaneously coming. This proved that radar can locate CATbut there is still a long way to go, from the great "dish" antennas at Wallops Island to a portable CAT-detecting radar that an aircraft can carry.

An optical method of detecting CAT with laser is under development at NASA's Marshall Space Flight Center Wind-tunnel trials of a carbon-dioxide-laser beam show that the motion of small particles in a turbulent air mass has a "doppler" effect that shifts the frequency of scattered light returning to a receiver. This directly measures the air's velocity; and the spread in velocity indicates the intensity of turbulence. An airborne CAT-detecting system based on this principle is now in the design stage, and several firms are working on its hardware.

But the infrared CAT detector looks like the most promising of all, and the furthest along toward an operational version. This is its ingeni-

ous principle:

For an indicator of air temperature it uses the infrared radiation from carbon dioxide gas, which is present in air everywhere. This radiation reaches an electrical detector through a rotating filter wheel, which alternately samples it at two slightly different wavelengths-14.1 and 15 microns

Because of the different ranges in air of radiation of these wavelengths. the 14.1-micron filter "tunes in" the instrument to sense the temperature of air 20 to 40 miles ahead; the 15micron filter, to sense the temperature of nearer air. A dial-needle reading. which shows the temperature difference, rises as CAT is approached.

Improved experimental versions of the infrared CAT detector are now getting practical flight trials aboard airliners of three leading lines: Pan American World, Eastern, and Trans. World. The latest model, besides providing both a visual and an audible CAT alarm, aids in taking evasive action. It can be set to scan the sky vertically for a CAT-free region, up to three degrees above and below the flight path-under control of the same gyro that normally keeps its onedegree wide field of view level.

When the results of these two-year trials are in, we should know whether we are ready to put operational CAT detectors in airliners for passengers' safety and comfort.



Exterior beams and columns, all hollow, are welded together for water-tightness

Water-Filled Columns Keep **Building Frames** Cool in Fires

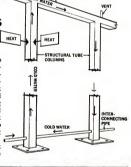
Problem: Architects wanted to use "weathering" steel-a material that acquires a handsome patina when assaulted by the elements—in the exposed framework of office buildings, to gain a bold new look. But many building codes insist that structural steel be encased in a fire-retardant coating, such as concrete, to keep buildings from collapsing during

Solution: an 86-year-old patent water-filled columns. In a spate

of new buildings, all the columns and floor beams are hollow and welded together. Pipes interconnect columns, turning the entire skeleton into a continuous network. All such structures are tested to make sure they are leakproof, then filled with a solution of water, rust inhibitor, and where necessarv, antifreeze. If fire attacks one part of the building, the water inside the beams is heated

and rises in the column. Cold water then flows into the hot fire area and the steel keeps its cool.

-Arthur Fisher





and beams of American Reserve Life Insurance Co. Building, shown here under construction, will save skeleton from fire damage. Diagram shows water dissipating heat. With a novel U.S. relay station to be orbited 22,300 miles high, India will pioneer in "skycasting" direct to TV sets on earth





India's satellite-to-receiver TV plan is envisioned in operation by General Electric artist. To villagers, left, community set brings educational program picked up by "umbrella" antenna (right background) direct from big dish antenna of the U.S. satellite, NASA's ATS-F, pictured above.

TV Broadcast Satellite

For the first time, TV programs will be broadcast from a satellite direct to viewers' receiving sets, through an agreement concluded at Washington on Sept. 18, 1969, by the United States and India. Under it, 20 million people living in 5,000 villages of India will benefit from a dramatic educational-TV project—and much of the world, the U.S. included, will be the gainer from the technological advances involved in carrying it out.

A milestone in the rapidly growing role of communications satellites, the U.S.-India pact signals the start of a trail-blazing experiment to fight ignorance and hunger in developing and overpopulated countries—particularly in Asia and Latin America, and possibly also in Africa.

U.S. to put up the satellite

The agreement calls for NASA to provide and orbit the world's first TV broadcast satellite, in a stationary or synchronous 23,00-mile-high orbit over the Indian Ocean. Flying at this altitude above the equator from west to east, the satellite will have a period of revolution of exactly 24 hours, just matching the earth's period of rotation. Thus the satellite will hang at a fixed point in the Indian sky, day and night, rain or shine.

The TV satellite will be one of NASA's Applications Technology Satellites, the ATS-F, now expected to be launched in early 1973. It will have a solar-powered 80-watt transmitter; a 30-foot-wide parabolic antenna aimed at the Indian subcontinent; and a suitable receiver to intercept a TV program beamed up to it from a central Indian ground transmitting station. The satellite will rebroadcast the program back to earth through a searchlight-type beam covering most of India.

The central transmitting station will be at Ahmedabad, about 250 miles north of Bombay. The government of India, which will establish this station, will also furnish 5,000 "village receivers." These community TV sets will be distributed among 5,000 villages in four Hindi-speaking states—Rajasthan, Bihar, Madhya Pradesh, and Uttar Pradesh. The Indian government plans to buy these receivers from local sources, thus combining the

"Father" of mighty Saturn V moon rocket, Dr. von Braun now heads NASA's plan-making at Washington. Earlier, he directed Marshall Space Flight Center at Huntsville. Dr. von Braun is PS Consulting Editor on Space.

educational merits of the program with a healthy shot in the arm for its domestic electronics industry.

The U.S.-India accord involves no exchange of money; the parties simply commit themselves to furnish their respective parts of the satellite TV system. The United States will stay completely out of the act of preparing the TV programs.

By Indian government plans, educational programs will provide what the people in those 5,000 villages need most. There will be "reading, 'riting, 'rithmetic" for the kids; there will be advice to farmers on how to plant, fertilize, and irrigate crops; and there will be counsel on hygiene and family planning, often eagerly sought. The programs are expected to be popular hits-for, as a United Nations official has observed, "The word 'education' in India is as holy as the cow."

Project challenges engineers

From an engineering standpoint, both the ATS-F satellite and the ground equipment pose many challenges, some unique.

The satellite will weigh about 1,600 pounds and will have a transmitter about three times as powerful as those in present communications satellites. The continuous fine-pointing of its large 30-foot dish antenna raises a number of unprecedented problems.

The antenna must maintain the angular direction of its searchlight beam with an accuracy of 1/10 of a degree. Much attention must be devoted to the antenna's power feed system to avoid undesirable "side lobes" in the radiation pattern, through which some of the emitted energy would spill over to countries bordering India. Fine-pointing also requires exact station-keeping of the satellite in its orbital position; here, too, accuracy specifications are tighter than for any synchronous satellite launched before.

The ground transmitter at Ahmedabad is relatively straightforward, but producing the 5,000 community receivers at acceptable cost offers more of a problem.



Beginning with Early Bird in 1965, all commercial communications satellites have relayed telephone calls, still pictures, and TV shows from an overseas transmitter to an elaborate multimillion-dollar receiving station capable of handling very weak signals. Processed and amplified, the TV signals then travel across country over microwave links, to be rebroadcast by local TV stations for nationwide reception.

nationwide reception.
India's key problem is that, except for one experimental government station in the area of the capital city of New Delhi, TV stations are nonexistent. Establishing them would be expensive and unattractive, because only a small segment of the population could afford private TV sets. Community sets, directly receiving programs beamed from a satellite in the sky, are indeed the only answer—if they can be built cheaply enough.

The "business end" of such a community set is not much different from your home TV set. It will have a 23-inch screen, black-and-white or colorand, with tubes and supporting electronics, can be had for something like \$500. But, to receive a TV broadcast from a satellite, the "input end" of the set must be quite different from the kind for your own receiver.

Set needs "umbrella" antenna

To intercept a maximum of the energy beamed down by the satellite, the standard rake-shaped TV antenna must be replaced by an 'umbrella' antenna of at least 10-foot diametermounted so as to be aimed precisely at the invisible transmitter hovering in the sky, more than 20,000 miles away. The weak signal picked up by this umbrella must pass through a preamplifier to a special converter, which changes the satellite transmission (UHF) into a signal suitable for reception on standard (VHF) television channels.

Today the combination of umbrella antenna, preamplifier, and converter still costs well over \$1,000. Together with the \$500 TV set itself, this would

U.S. will benefit from success of plan for a TV broadcasting satellite

run the cost of a village receiver to something like \$1,500; and of the whole 5,000 sets to \$7½ million. But mass-production techniques can be expected to reduce the total cost of a community set to \$500, saving the project a tidy \$5 million.

Considering the much higher cost of the satellite itself, a difference of \$1,000 in a community receiver's cost might not seem too important at first glance. But the U.S.-India project is viewed by both parties as an experiment that, if successful, may pave the way for a vast extension of the system of broadcasting TV programs from a satellite.

Bigger plans ahead

India has a total of 530 million people, the great majority of them scattered in no less than 534,000 villages. Eventually, India looks forward to a satellite-TV network covering all this territory, and capable of handling TV shows narrated in any of its 120 different languages and dialects. The importance of cheap ground sets for such an extended project is obvious.

Only a relative few of India's villages have rural electric power for the receiver sets. While a few more can bring it in from nearby lines, most village sets will have to be powered by generators driven by lawn-mowertype gasoline engines (hopefully noiseless). It is not unlikely, however, that in many locations a man pedaling away on a stationary bicycle will take the place of the little gasoline engine, to generate the 100 watts or so required to power the receiver station. That primitive way to obtain electricity will make a curious contrast with the advanced technology represented by the ultramodern TV satellite system.

Brazil, too, is interested in using an ATS satellite to broadcast educational TV. Its plan, under US. study, would place the receiving sets in schools—first, several hundred schools in the state of Rio Grande do Norte, and ultimately as many as 150,000 throughout the country. During evening hours, the system could serve for adult education. A ground transmitting station at Natal on the Atlantic coast is envisioned for the Brazilian satellite-TV project.

In our interdependent world, the U.S. has much to gain from improved living conditions in developing countries. And TV broadcast satellites may have more direct benefits for us, nearer home. Our own state of Alaska is one of many world areas where they appear to have promise.

For most of the U.S., already served by the vast network of local TV stations and microwave links that brings you TV now, direct satellite-to-viewer TV broadcasting looks more distant and controversial. Nevertheless, it has been getting serious study by leading electronics firms, as evidenced by reports to NASA of GE and RCA progress in designing suitable equipment. And a recent report by John L. Hult, a Rand Corp, researcher, champions the feasibility of receiving TV direct from a high-power broad-cast satellite—wherever you may gowith a portable antenna small and flat enough to be installed in your car's roof.

Currently discussed as a U.S. possibility, too, is another innovation in communications satellites—a domestic system of "distribution" satellites that might challenge the present microwave land systems as a means of linking the country's network of local TV stations.

A look into the future

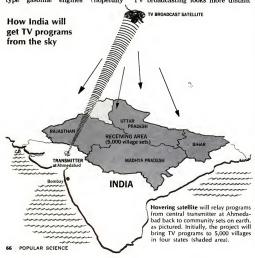
All in all, you are bound to benefit from communications satellites in your lifetime. Arthur C. Clarke, the perceptive British writer and originator of the idea of synchronous communications satellites, sees this prospect ahead:

Imagine a console in your office, he says, combining the features of a Touch-Tone (pushbutton) telephone, a television set, a Xerox machine, and a small electronic computer. Tuned in to a system of synchronous satellites, this console will bring the accumulated knowledge of the world to your fingertips.

By punching a few digits, you can verify a check, get the data on some historical event, or hear an illustrated lecture on any subject you wish. Or you can hold an electronic conference with any group of people scattered all over the world, seeing each other as you talk. And the console will even provide you with a document to seal an agreement.

Once we all have such a console, Clarke foresees, we'll have little need for business trips, and will limit our traveling to the pursuit of fun. A man will be able to run his business just as effectively from a ranch in Wyoming as from an office in New York City or Chicago.

If Clarke is right, better communication via satellite could stem or reverse America's trend toward the big city—and alleviate problems like urban decay, smog, polluted rivers, clogged traffic, and crowded airports. These effects, of course, would be long-term. But, just as the telephone and airliner helped make the U.S. a great nation, so the communications satellite may yet turn out to be the greatest thing the space program ever contributed to this country.



The Case for Central Air Conditioning

It can bring constant, yearround comfort to your home at less cost than room units

By JACKSON HAND

Yesterday's air conditioner—the window-mounted appliance that merely blew cold air into a room—will soon be as obsolete as the electric fan. Today's air too often needs more than a drop in temperature to make it fit to live with. So air conditioning is now a composite of functions that takes

discharged by an exterior unit.

whatever atmosphere this age of pollution happens to waft into your back yard and transforms it into a houseful of air worth breathing. Not just in the summer, but in the winter as well and 24 hours a day.

New and updated systems now make it possible for you to control the

make it possible for you to control the climate inside your home. And you can add many of the features of such systems to your existing heating system—especially if you already have hot-air ducts.

 Continuous air circulation—24 hours a day, all year around—is now considered essential to effective air treatment. To implement this, General Electric, for one, has devised controls that produce two levels of cooling and three of heating. As the load changes, the system senses the need for more or less volume and adjusts to output automatically. In some gasfueled cooling-heating systems, the flame rises and lowers.

 Quiet air circulation is here, now that ductwork has some of the corners rounded and may be made of fiberglass. Along with this, nearly all manufactures have switched to squirrel-cage fans. Bryant has a motor slowed down to 800 rpm for greater quiet. The noise of compressors is now housed inside high-mass castings and hardly a whisper escapes.

· Design is tightened. Central air-

There's more to air conditioning than cooling CONDITIONED ALL COOLING What you're after, when you sel out to "condition" air, is a com-CLEANING fortable temperature first of all. But humidity is also importantnot only for its effect on you, but on your possessions-including the house itself. Too much induces rust and rot; too little causes furniture and fabrics to dry out and deteriorate. Moisture is added to the return (indoor) air or removed from the cooled air-whichever is required at the moment. Air is also electronically cleaned before recirculation. Units such as the Precipitron, here, charge pollen and dirt particles so they are drawn to electrified plates. Such cleaning relieves allergy conditions and reduces need for frequent dusting. Important, too, are fans which keep conditioned OUTDOOR COMPRESSOR air circulating throughout the house. The compressor is the heart of the cooling system. It pumps refrigerant through the indoor coils. Heat absorbed by CIRCULATING these from indoor air must be

Drawing by Sigman-Ward from material supplied by Westinghouse



COUNTERLOW

There's a system to fit every house

No basement is needed for central systems, as top two sketches show. Upflow unit can be installed in closet or utility room with cooled or heated air distributed through ductwork above ceilings. In two-story home, ducts run under floor, with outlets aimed upward-similar to basement system at right. Counterflow unit (top right) puts ductwork in crawl space, with conditioned air discharged from base of furnace.



treatment systems are as much as onethird smaller. You no longer have to give up half a garage or basement to equipment. Part of the compactness is due to all-in-one designs. Williamson puts heating, cooling, humidification, and air purification all in one small unit, as do several other manufacturers, in products balanced a bit more toward winter than summer.

- Exterior cooling units, an integral part of most high-capacity airtreatment systems, are now actually small enough to be camouflaged with a few plantings. Carrier has an outdoor component that discharges hot air straight up, thus sparing nearby shrubs that would be scorched by air discharged laterally. Another improvement in the outdoor component is one that has air intake and outlet on one side, so that it can be mounted in an above-grade basement wall.
- Electronic filters of Westinghouse's "Precipitron" type, are capable of removing almost 100 percent of pollen, smoke, dust, and other contaminants. Bryant has one that you throw away when a pilot light comes on to tell you it's full of dirt. Other varieties can be hosed off and put back into service without even a delay for drying. Air-purification units may also include a germicide in a permasent.

nent form; it doesn't wash off. The Fedders electronic control has a "sail" switch that turns the air cleaner on when the air starts to move, turns it off when the air stops, and thus saves operating and upkeep costs.

- New devices have been developed that absorb odors from air passing through the system. One of these, reported by Carrier, uses a filter bathed by a chemical solution in which odors are continuously absorbed and then boiled off through an outside vent. The solution, incidentally, also washes the filter, ending the need for filter cleaning or replacement. As if that weren't enough, it provides the humidifying function needed in winter time heating.
- Choice of fuel (oil, gas, electricity) is available in most major lines, letting you pick the one that is most efficient and economical in your area.
- The heat pump is making a return after early disappointments.
 Airtemp has one now that will give you 44,000 BTU of cooling and 47,000 BTU of heating.
 Lennox covers the complete heating-cooling are with a unit that automatically delivers its air cooled or warmed, depending on household temperatures.
- Cooling phases of air treatment automatically dehumidify to a com-

fortable moisture content, but warming phases dehydrate the air, so moisture must be added. The systems of the 70s will add 15 to 20 gallons of water a day—or more—to the air.

New concept: CAC. No, those ini-

New concept: CAC. No, those initials don't stand for central air conditioning, but rather for the latest concept in total climate systems—controlled air circulation. Any system that doesn't feature CAC is less than efficient. Fortunately, CAC can be added to most existing systems—not only new installations.

A spokesman for Lennox, citing the advantages of CAC, points out that on-and-off systems have a cycling and recycling of good air, then less-thangood. While the equipment is off, there's no improvement in the air. When it cycles on, the situation gets slowly better, until full treatment is in operation. Then it cycles off, and the total situation gets slowly worse, until it zeros off and sits there waiting for the cycle to start again. Meanwhile, rooms do not react equally to either the on or the off phase. As a result, the so-called central air treatment system is spotty throughout the house and throughout the day. CAC. working all the time, tends to average out conditions so that a room that's hard to cool "borrows some of the







Year-round total comfort is boast of GE system with electric furnace plus central air conditioner (36,000-63,000-BTU capacity).

Two other types of exterior units, above: Carrier's cooler with top discharge; Bryant's gas-fired chiller at corner of a patio.

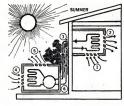
ow a heat pump cools or heats-depending on outdoor temperature

the widely misunderstood heat mp could be the nearly perfect me for heating or cooling. It's more cient than any other method of proing heat. It uses no fuel-except for tricity to run a compressor and a place of fans. It manufactures heat of-literally—thin air, operating on same principles as the familiar hen refrigerator:

When a liquid turns into a gas porization) it absorbs heat.

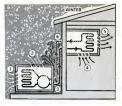
When that gas returns to liquid n (condensation) it gives off heat. y controlling vaporization and consation, and by pumping the gas and id through tubes, you can force the to pick up heat in one place and p it in another. Thus, you can mp" heat around to suit your needs. the pump picks up its heat in a se that is too hot and dumps the t outdoors, it cools the house. If icks up its heat outdoors (there is in the air, even in the coldest ther) and dumps it inside a house is too cold, it warms the house. It do either at the flick of a switch. the switch can be activated by a mostat set at the exact dividing line veen too hot and too cold.

heat pump is, mechanically, little et han a circuit of fubing, half inthe house, half out—with a coil or exchanger at both ends. The comsor and fans move the air, and e's a valve to reverse the action. system uses a special liquid that exles into a gas at temperatures well we freezing; action is accelerated by



- 1. Warm air in house passes through heat exchanger, where refrigerant is vaporizing, picking up heat.
- 2. Air, with heat removed, is blown into the room.
- 3. Vapor takes its load of heat outdoors where it condenses, giving off heat to heat exchanger.
- 4. Outdoor air blows through the finned heat exchanger, absorbing the heat.
- Hot air is discharged into the atmosphere.
- Liquid continues the cycle, returning inside the home to pick up another charge of heat and carry it outside for dumping.

reducing pressure on the liquid at the point where it vaporizes and increasing pressure at the point where it condenses. Heat pumps tend to cool a bit



- Outside air passes through heat exchanger where liquid is vaporizing, picking up heat.
- 2. Extremely cold air (de-heated) disperses in atmosphere.
- 3. Vapor, with load of heat, passes inside, where it condenses, giving up its
- Inside air passes through heat exchanger where it absorbs heat from the condensing vapor.
- 5. Warm air is discharged from exchanger into the room.
- 6. Liquid is pumped back outdoors to continue the cycle.

better than they heat, so extremely cold climates and "inefficient" houses may need a boost from an electric element, thermostated to come on when needed.

cool" from a room that's easier. The same leveling out works in heating. In case after case, home owners re-

port savings in fuel up to 25 percent since there are no lows to recover from, no need to overwork to catch up. Air that's fit to breathe also makes for easier housework. Draperies, walls, floor coverings, upholstery all stay clean longer. The slight inside pressure produced by continuous air circulation keeps dirt-laden air from coming in through inevitable cracks

and crevices in the construction.

Peace and quiet are additional advantages. With windows and doors shut, less outside noise intrudes.

(Harder for burglars, too.)

Your year for climate controlt About eight percent of homes in America have central air conditioning. Over a control air conditioning to the control air conditioning. Over a conditioning the central air conditioning. It has reached a point where homes with air conditioning are snapped off the real-estate market, while other

houses sit - they're underequipped.

Building a house? It makes less than sense to let a new house go up without a central air-treatment system that heats, cools, cleans, and controls humidity. The mechanical equipment required costs less at the time of construction (because of efficiencies in combined heating-cooling units) than it does as an add-on later. However, if there are budget reasons why the complete system cannot go into a new house now, the wise thing is to have the engineering and design phases done. That way, you'll be ready for simple add-on, later.

If you own a house with a ducted warm-air system, you may be only a short step away from CAC:

[Continued on page 132]

What 24-hour cooling costs per season

Your temperature zone makes a big difference, though individual homes vary, too. Here are average cooling costs per ton 112,-000 BTU = 1 ton) at 11½c per kilowatt hour.



SKAMP-

Robot Boat with Rigid Sails Patrols Ocean Beat

By BOB SMITH ILLUSTRATIONS BY THE AUTHOR



A new unmanned, self-navigating sailing craft promises to change the entire course of pleasure boat cruising. If enough of these rigid-sail vessels were posted, you could actually "road sign" your way over unmarked oceans. And if set up as fuel, water, and food stations, you could literally cross the ocean in an outboard with their aid.

The prototype of this Station Keeping and Mobile Platform (SKAMP) has already been built and successfully tested by RCA's Astro-Electronics Division. The power developed by only 50.4 square feet of projected area in SKAMP's sophisticated sail is phenomenal. It drives the semi-submerged disk, with its complicated, heavy underwater structure, at better than 4.5 knots. Just think how fast the thing could go on an easily driven hull like a catamaran, or a racing monohull.

For the present, SKAMP is de-

signed as an instrument-carrying robot sailboat. It will either maintain station or sail from point to point-directed by a preprogrammed onboard control system, or by external commands from shore stations, satel-thermands

lites, or ships.

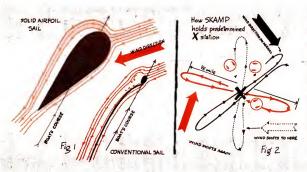
In fact, on electronic impulse beamed via satellite, this odd-looking craft can reposition itself or come home. Ernest W. Schlieben, manage of oceanographic programs at RCA says SKAMP is designed to maintain station in deep water without expensive mooring devices such as those required by deep-sea buoys and platforms now in use.

Ships used for weather and iceberg patrols, current monitors, and other oceanographic duties could be replaced by a fleet of SKAMPs. The financial savings to taxpayers would be enormous.

In addition to replacing costly

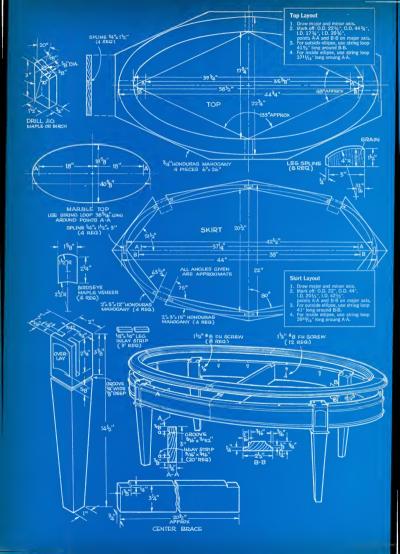
[Continued on page 142]

Designed with rigid plastic sails and space-age guidance equipment, this crewless, seagoing beacon and traffic cop keeps station automatically



How solid airfoil gets its and keeps SKAMP on ats is shown in these draw Airflow (Fig. 1) is smoo around solid sail, whe mast creates eddies in flow around conventit sail. Camber of solid sa also thicker, and there yields greater lift. Beam re ing back and forth ko SKAMP on station (Fig within one-fifth of a mili point. As wind chan SKAMP adjusts wind-re ing position accordingly







LIKE FINE FURNITURE? HERE'S A

Marble-Topped Table You Can Build By FRANK GREENWALD

There is a saying in our family that "We can't afford the furniture we like and we don't like the furniture we can afford." So, when the general manager in our household announced she wanted a coffee table, I retired to the drafting board with her specifications.

This marble-topped table is the result. The top should be obtained before you begin. Mine is a half-inch thick. Most larger cities have firms that cut and grind marble. In many smaller towns a local firm handling the sale and installation of ceramic tile will take an order for a marble top cut to your specifications. Sometimes an antique marble slab can be cut to your pattern by a monument maker. Marble can be supplied with either a polished or honed finish. The honed finish is better for a table top since wet glasses will not leave rings.

Although marble is first choice, other materials might be substituted. Black Carrara glass 11/32-inch thick can be obtained from a glass or mirror company. Phenolic laminate in a marble pattern mounted on 3½ or 1½" plywood will make a top that looks like marble. A kitchen-cabinet shop can supply it.



Good detailing adds quality and craftsmanship to the table. Bird's-eye maple veneer tops each leg. Twin beads are inlaid around apron, one on legs.

For a picture story on how to build the table, please see page 110





Include

By THORN BACON

A small tripod will hold your camera while you move into any picture. You can get smaller, pocket tripods, easy to carry along on long hikes. When you look at most family travel photos you'd think Dad hadn't been along-he was busy taking the pictures. But there's no reason why the photographer can't get into his own photos-even when he travels alone. Use a self-timer. If your camera doesn't have one you can get an accessory timer for a few dollars. Either way you get delayed shutter-tripping (usually around 10 seconds) that gives you time to step into position. A small tripod or clamp support to hold the camera, plus the tips on these pages, will help you get into your photos, and improve them too.







stages of your trips. Here the photographer prepares to take to the water in a kayak.

era could topple, or even fall overboard. Use a clamp support such as a Steadipod.

the areas you visit. The cactus in this photo clearly says "southwest" to the audience.

Record your campsite, too. For best composition, plan ahead of time where you want to appear in the picture. Most often it's best not to pose in the exact center of the area to be photographed. To help you remember where pictures are taken you can include site markers or signs. Put them near the edge of the scene where they can be seen clearly, but won't draw too much attention.





ver 200 events of interest to PS readers, where and when they happen



O CAMPING EVENTS

7. Family Motor-Coach Assn. Raily — Costa esa, Calif., July 27-29. 3. Winnebago International Travelers Raily—

5. Winnebago International Iraveiers Raily— in Bernadino, Calif., May 15-17. 6. Indiana All-State Spring Campers Invita-onal — Lafayette, Ind., May 15-17. 9. Midwest Mobile-Home and Recreational-chicle Show — South Bend, Ind., Aug. 18-23.

shicle Show — South Bend, Ind., Aug. 18-23.
L Brown County Fall Campers Invitational— ashville, Ind., Oct. 2-3.
National Family Campers Assoc. Fall Froi-s — West Brookfield, Mass., Sept. 25-27.
Shallon James Assoc. Spring fari — West Springfield, Mass., May 15-17.
Link James Camprention— Irish Hills, inh. July 13-16. ich. July 13-16.

State Campout - Bath, N. Y., May 29-31. 5. National Family-Campers Assoc., Spring afari — Gilboa, N. Y., May 15-17. 7. Spring Statewide Campout—Croton, Ohlo, ay 22-25.

ay 22-25. B. Penn Camp—Centre Hall, Pa., June 19-21. 9. 13th Annual State Campvention — Wau-oma, Wis., June 19-21. D. International Wally Byam Caravan Rally—

aramie, Wyo., July 5

MOTORCYCLES

1. 200-Mile National Championship Road ace - Talladega, Aia., May 17.

92. 100-Mile National Championship Endurance Run — Nebraska City, Neb., Oct. 4. 93. 400-Mile National Championship Endur-ance Run — Lansing, Mich., Sept. 12-13. 94. Professional-A Hillclimb National Champlonship — Muskegon, Mich., Aug. 2. 95. 15-Lap One-Mile Dirt Track National Cham-

plonship — Sedalia, Mo., Aug. 30. 96. 100-Mile National Championship Road - Loudon, N.H., June 14 20-Lap Half-Mile Dirt Track National Championship — Columbus, O., June 28. 98. Moto Cross National Championship — Croton, O., Sept. 27.

98. Moto-Cross National Championship — Croton, O., Sept. 427. htt Track National Cham-99. 20-Lap Half-Miles City, Okla., Oct. 4, 100. Black Hills, Rally—Sturgis, S.D., Aug. 5-9, 101. 125-Mile National Championship Road Race — Memphis, Tenn., May 24, 102. 125-Mile National Championship Road Race — Dallay, Tex., Oct. 11, patonship — Cas-

103. 30-Lap TT National Championship - Castle Rock, Wash., July 11.



OFF-ROAD VEHICLES

104. National Off-Road Equipment and Racing Show — Anaheim, Calif., July 22-26. 105. Borrego Rough 100 — Ocotillo Wells, Calif., mid-Jan. 1971.

106. Four-Wheel-Drive Club Rally — Pismo Beach, Calif., July 4, Labor Day. 107. Off-Road Grand Prix — Riverside, Calif., early April, 1971.

108. Jeepers Jamboree – Lake Tahoe, Calif., July 25-26. 109. Swamp-Buggy Days – Naples, Fla., late

110. Four-Wheel-Drive Fiesta - Truth Or Consequences, N.M., May 1-2. 111. Rio Grande Prix — El Paso, Tex., late Dec.

State

112. Baja 500 — Ensenada, Mexico, June 9-12, 112. Mexican 1,000 — Ensenada, early Nov.



○ WATER SPORTS

113. Dixie Cup Hydropiane Race — Gunters-ville, Ala., early June. 114. World Championship Speedboat Race — Lake Havasu, Ariz., Nov. 28-29. 115. Lake Powell Boat Trips - Page, Ariz.,

116. Colorado River Cruise - Blythe, Calif., Oct. 3-117. Hennessy Cup Powerboat Race - Long Beach, Calif., Aug. 15. 118. California Cup Regatta - Modesto, Calif.,

May 17 Needles, Calif., Sept. 18-20.

120. Surf Capades — San Clemente, Calif.,

mid-Oct 121. Unlimited Hydroplanes Championship Race — San Diego, Calif., Sept. 20. 122. Ensenada-Newport Yacht Race — San

122. Ensemble Helper Facility Race — San Ysidro, Calif., May 5. 123. Yale-Harvard Crew Races — New London, 123. June 13. 124. Sunrise Slalom and Water-Ski Tourna-ment – Grand Lake, Colo., June 6-7. 125. Arkansas River International White-Water

Arkansas river international wine-water trace — Salida, Colo., mid-June. President's Cup Regatta — Washington, weekends in June, Aug., and Sept. Sam Griffith Memorial Race — Ft. Lauder-

127. dale, Fla., May 1. 128. Hennessy Cup Powerboat Race — Key West, Fla., Nov. 6.

Miami-Nassau Race - Miami Beach, Fla., Fiesta of the Five Flags - Pensacola, Fla., June 6-14

131. Christmas Boat Parade-Pompano Beach, Fla., mid-D 132. Unlin Unlimited Hydroplanes Championship Race — Tampa, Fla., June 7.

133. Gateway Marathon — West Palm Beach,

Fla., May 10. 134. Miniature-Hydroplane D'Alene, Ida., July 19-26. Races - Coeur

more

RFF TO POPULAR SCIENCE READERS

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Name	
Address	
City	

MAY 1970 79

135. Chicago-to-Mackinac Sailboat Race -Chicago, III., July 18. 136. Outboard Nationals - DePue, III., July 31-Aug. 2. 137. Midwestern Boat Races — Rockford. III... various summer events. various summer events.

138. Whitewater Canoe Race — Matamora, Ind., Sept. 26-27.

139. Unlimited Hydroplanes Championship Race — Madison, Ind., July 5.

140. Unlimited Hydroplanes Championship Race — Champ Race — Owensboro, Ky., June 14. 141. Tarpon Rodeo — Grand Isle, La., July 142. Long Lake Regatta - Madawaska, Me., lune 27 143. Chesapeake Appreciation Day — Annapois. Md., Oct. 31. 144. Bay Country Festival — Cambridge, Md., Aug. 17-23. 145. Marbiehead Race Week — Marbiehead, 145. Marbiehead Race Week — Marbiehead, Mass, July 26-31. 146. Quincy Bay Race Week — Quincy, Mass., Aug. 5-9. 147. Unlimited Hydroplanes Championship Race — Detroit, June 28. 148. Annual State Jaycees Canoe Race — Grayling, Mich., Aug. 8-9. 149. See No. 135. 150. Seaway Festival - Muskegon, Mich., June 27-July 4. 27-July 4.

151. Sall-Boat Race — Macatawa, Mich., Aug.
14-21 (leaves from Racine, Wis.).
152. Blueberry Festival Boat Races — South
Haven, Mich., July 26.
153. Inboard Nationals — Ypsilanti, Mich., July 25-26. Championship Water-Ski Races — Lake Nev., Sept. 18-19. Great Bay Day — Portsmouth, N. H., Sept. 5-7. 156. Fishing Rodeo - Atlantic City, N.J., May 29.31 156. Tuna Tournament — Atlantic City, N. J., 156. Martin Tournament - Atlantic City. N.J.. Aug. 4-7. 156. Striper Derby — Atlantic City, N.J., June 23-26; Sept. 7-Oct. 26. 157. Motorboat Regatta - Long Branch, N.J., July 12. 158. Hennessy Grand Prix — Pt. Pleasant, N.J., 159. Thousand Islands International Antique-Boat Show — Clayton, N.Y., Aug. 15-16. 160. Gen. Clinton Canoe Regatta — Cooperstown, N.Y., May 30. 161. Lake Trout Derby—Geneva, N.Y., May 30. 162. Larchmont Race Week — Larchmont, N.Y.,

165. International Rowing Assoc. Champion-ships — Syracuse, N.Y., June 11-13. 166. International Cup Regatta — Elizabeth, City, N.C., late Sept. 167. Blue Marlin Tournament—Morehead City, early June. Saliboat Regatta — Washington, N. C., early June. 169. Water-Ski Carnival — Bottineau, N. D., July 4. 170. Trophy Race — Put-In-Bay, O., Aug 171. South-Shore Regatta — Vermillion, Aug. 7-9. 172. National Sand-Bass Festival – Lawton, ., June 14-21. 173. Boat Races — Newberg, Ore., May 30. 174. America's Cup — Newport, R.I., Sept. 15. 174. Newport-Bermuda Race — Newport, R.I., Water Festival - Beaufort, S. C., July 20-26. 176. Aqua-Speed Week — Galveston, Tex., May 177. Fishing Fiesta — Freeport, Tex., July 3-5. 178. Clear Lake Rendezvous Festival—Houston, Tex., June 5-14. 179. International Fishing Tournament - Port 179. International Fishing Tournament — Fort Isabel, Tex., Aug. 180. Canyon Country Friendship Cruise to Moab — Green River, Utah, May 22-23. 181. Moab, Utah — finish point of No. 180. 182. Inboard Nationals — Ogden, Utah, Aug. 7.9 183. Utah Lake Boat Ragatta - Provo, Utah. late May. 184. Fourth of July Regatta—Tappahannock, Va. 185. Kon-Tiki Raft Race and Water Carnival — Kelso, Wash., June 6. 186. Seafair — Seattle, Wash., July 24- Aug. 2. 187. Outboard Stock Nationals — Beloit, Wis., Aug. 19-23.

188. Menominee River Canoe Race — Mari-

163. Old Whalers Festival - Sag Harbor, N.Y.,

64. Agua Festival - Seneca Falls, N.Y., Aug.

nette, Wis., July. 189. Sailing Regatta — Alcova Park, Wyo., July 24-26.

190. Midnight 600 Snewmobila Raca – Anchorage, Alaska, Jan. 1971.
191. World Cup Ski Meet – Heavenly Valley, Calli, Mar. 1971.
192. Barrel Stave Olympic Stalom – Lake Tahoe, Calli, early Mar. 1971.
193. Ulir Dag Winter Festival – Breckenridge, Col., early Feb. 1971.

194. Winter Carnival - Leadville, Colo., late Feb. 1971. 195. Winter Carnival - Steamboat Springs, , mid-Feb. 1971. International Ski Races—Sun Valley, Ida., 196. late Mar. 1971. Snowmobile Races - Ironwood, Mich., 198. Winter Sports Festival - Petoskey, Mich., late Jan. 1971. 199. Soo Snowmobile Races—Sault Ste. Marle, Mich., early Feb. 1971. wmobile Races - Brainerd, Minn., 201. Birchwood Snowmobile Races - Duluth, Minn., Jan. 1971. 202 Winter Carnival - St. Paul, Minn., late Jan. 1971. 203. Snowplane Races - Dillon, Mont., early 204. Snowmobile Races — West Yellowstone, Mont., Dec. 1970 and Mar. 1971. 205. Winter Carnival — Franklin, N. H., Feb. 206. Winter Carnival - Laconia, N. H., Feb. 1971 207. Winter Carnival - Saranac Lake, N.Y., Feb. 1971. 208. Snowmob mid-Feb. 1971. vmobile Races - Boonville, N. Y., 209. North American Winter Festival - Lake 209. North American Winter Festival — Lake Placid, N.Y., Jan.-Feb. 1971.
210. International Winter Fastival — Niagara Falls, N.Y., Feb. 1971.
211. Governor's Cup Snowmobile Race—Minot-Bismarck, N.D., Mar. 6-7, 1971.
212. Winter Carnival — Brattleboro, Vt., Feb. 213. Siush Cup Ski Races-Bellingham, Wash., July 4. 214. Snowmobile Races — Eagle River, Wis., late Jan. 1971. 215. Snowmobile Races — Rhinelander, Wis., mid-Jan. 1971. 216. Wild-West Classic Ski Meet — Jeckson obile Races - Rhinelander, Wis., Hole, Wyo., mid-Feb, 1971.

NOTE: Dates are tentative in some instances. Some events may be postponed or cancelled because of unfavorable weather. You should check with local Chambers of Commerce to confirm times and places.

Also, some of these outdoor spectacles may be postponed if weather or other conditions are not right. For instance the speed trials at Bonneville Salt Flats are run only when the salt is just right. Some races may not be held in inclement weather. So it's generally a good idea to make a last-minute weather check to insure that the thing you want to see or take part in is definitely on before you make a long trip.

You'll notice that the events are not confined to summer vacation months, but are spotted around the calendar. That's because people are on the go throughout the year, and there are numerous off-season spectacles that are worth a trip.

Some of our late-year favorites include the World Championship Speedboat Race at Lake Havasu, Ariz. on Nov. 28-29; the U.S. Grand Prix at Watkins Glen, N.Y. on Oct. 4, which is the only Formula I race held in this country; and one of the ruggedest offroad races in the world, the Mexican 1,000 at Ensenada, Mexico in early November.

Winter sports warm your blood? Try taking in some of the wildly exciting snowmobile races that are growing in popularity. Rhinelander and Eagle River, Wis, are two hotbeds of snowmobiling in January.

Water sports are solidly represented on the map with sailing regattas, fishing rodeos, powerboat races, and white-water cance races. Why not take your boat along and join the spectacular cruises on the Colorado and Green Rivers? Or try your hand at one of the fishing tournaments that are part of many water carnivals.

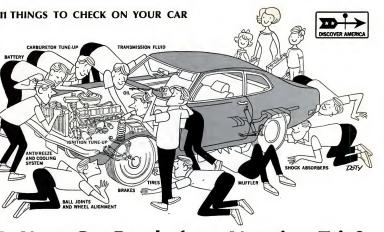
If the great outdoors is where you like to pitch your bed, you can join one of the camper jamborees, and swap experiences with people who share your enthusiasm.

Flying fans can choose from a number of interesting events, including races, parachute meets, soaring, and static air shows. The Reno/Stead Airport is the scene of the National Air Championships, sort of the World Series of private flying.

Auto racing is a big favorite with PS readers and you'll find a fair sampling of these events on our mapranging from the heralded Indy 500 to lesser local races that are just as timulating to those who watch them

We've taken all the events and placed them on a map that embodied the newest drafting techniques. If shows the interstate highway system to date. It also shows other majol turnpikes and toll roads, as well as the Trans-Canada Highway. The scale of the map is one inch to 186 miles.

See the box on the preceding page for how to get a free giant-size copy of this four-color map for use on you own vacations.



Is Your Car Ready for a Vacation Trip?

By JAN P. NORBYE
PS Automotive Editor
DRAWING BY ROY DOTY

detting ready for your upcoming vacated to the family car in shape. You'll probably be driving long distances at high speeds in summer heat, loaded down with kids and luggage. To make sure your car can take the strain, more than a tune-up and oil change are in order. Here are important things to check before you hit the road:

Cooling system. It's just as imporant to use anti-freeze in the summerime as it is in the winter months. Modern pressurized cooling systems are designed for operation at temperaures above the boiling point of pure water. A 50/50 mixture is recomnended. Make sure the radiator cap nolds pressure. Check the fan belts or tension. If a belt is shiny on both aces of the V, it's too loose, riding oo deep in the pulley grooves, or too vorn. A belt should not bottom in the oulley. If it's ragged along the edges, t's misaligned. Replace it and adust as required.

Oil and water leaks. Look for sludge nside the rocker covers. That could nean a crankcase vent is clogged or hat the rings are worn. If the sludge eels tacky, it contains anti-freeze,

which means there's a leak. Water stains on the engine are light brown or reddish-brown. Where you find such stains, look for leaks in hoses, gaskets and core plugs. Leaking engine oil will leave its marks where the air from the fan has blown it. If the metal around the fuel pump is cleaner than other parts, there's a gasoline leak. Clean the oil breather cap and check the crankcase ventilation system. This will help avoid sludge formation and excessive oil consumption, and assure proper disposal of blowby gases. Put a piece of paper film over the breather pipe while the engine is idling. If there's no suction, the PCV valve is clogged. Clean the valve and the air cleaner.

Transmission. Check the fluid level in your automatic transmission, and replace it if it shows signs of overheating. Adjust the throttle linkage and idle speed—this will help avoid burned-out sprag clutches and brake bands, damaged gears, slipping, or total transmission failure. If you have a manual transmission, adjust the free play in the clutch pedal to the spec'fications.

Electrical system. How's your battery? Be sure it has plenty of water and that the connections are clean and tight. Don't start out on a long trip with a weak battery, thinking that hours of driving will recharge it. It may have a faulty cell and not be able to take a full charge. Fix any malfunction in lights and wipers. Carry a new set of wiper blades, too.

Tires and front end. This is the time to take a critical look at those tires. They may be good for many more miles of city-and-suburban use, but don't ask them to run all day at turnpike speeds. Make sure you have four good tires, plus a spare in good condition, properly inflated. Get your front wheels realigned if you have any trouble with uneven wear on the front tires or feel side pull in the steering. If your car is getting on in age, inspect, repack, and adjust the frontwheel bearings. Check ball joints and steering linkage for play. Replace if wear exceeds specs. If the car has a sloppy ride, you probably need new shock absorbers.

Brakes. Noisy? Pull to one side? Worn linings? If in doubt, check them out. A brake job in time does not cost much, but if you wait, you may need an overhaul on the road, which is expensive and causes delay.

Ethaust system. Inspect the pipes and the muffler for leaks. Fasteners may be rusted or loose. If the muffler feels soft when you press your thumb against it, it may need replacement. Know your exhaust. Black smoke indicates too rich a mixture. Bluish smoke indicates the engine is burning oil. Don't start out on a trip with a sick engine.



Get a Flying Start on Your **Camping Vacation**



New vacation package: Your camper is delivered to you on your arrival a

Fly-in/Camp-out holidays in the outdoors add to your days at faraway places by eliminate

By HERBERT SHULDINER

Early one morning recently, my wife and I left our suburban New York home for a four-day trip in a camper along Florida's Gulf Coast.

Sound too ambitious to cover that much distance in only a few days? Not with the flying start we got on our vacation. Thanks to a new Fly-in/ Camp-out program pioneered by Camp America, Inc., and Eastern Airlines, we were having lunch in our rented camper on the beach near Tampa, Fla., only a few hours after leaving home.

We covered the first 1.100 miles in a short flight from New York's Kennedy Airport to Tampa aboard an Eastern Airlines 727 jet. Waiting at the Tampa Airport was a van-conversion camper we had reserved at the time that we bought our flight tickets.

The van (made by Recreational Enterprises Corp., Gainesville, Fla.) is only one of four units you can rent in the Fly-in/Camp-out program. The others are a Winnebago truck camper that sleeps four, an Open Road chassis mount that sleeps six, and a 22foot Winnebago motor home that sleeps eight. Rates run from \$99 a week for the small van to \$297 a week for the chassis mount. There's also a 10-cent-per-mile charge in addition to the basic rental.

The camper we picked up was

equipped with built-in stove, sink, refrigerator, and bedrolls. And it was clean and in fine working order.

Debark-and roll. As soon as we collected our bags, we pulled out of the airport parking lot and were on our way. A short ride brought us to the beach at Longboat Key, just outside of Sarasota. We spent the afternoon relaxing on the white gulf beach under the Florida sun. Later, we got back into the camper and rolled down route 72 to Myakka River State Park, where we camped for the night.

By the end of our first day away from home, we had traveled over 1,200 miles-yet we had spent only a few hours driving. We felt fresh and relaxed as we sat down to supper that evening. Estimating conservatively, we had saved about three days driving time in getting to Florida-at the rate that I normally cover on a trip.

Myakka Park has fine camping facilities and abounds with marvelous specimens of wildlife. But it has the foulest-smelling water I've ever en-countered while camping. So make sure you bring your own water should you ever go there.

The next day we headed south to the Shell Islands, off Fort Mevers. and made camp on Sanibel. This island is famous for the number and variety of sea shells that are washed up on its shores by the gulf waters [see the PS travel map, p. 76]. If you've never collected seashells before, you'll undoubtedly start a co lection with the fascinating spec mens you'll pick up here. We foun our stay regrettably short.

Emplane-and relax. We heade back across the connecting causewa to the mainland at the last possib minute for the return to Tampa Ai port. We arrived about an hour b fore our scheduled return flight New York and packed our bags the airport parking lot. Then v walked into the terminal and turne in the camper keys, just in time catch our flight-again saving a tir some three-day drive back home.

The way I figure it, flying to Flo ida and back gave us a 10-day vac

Here are the vehicles y



Adventure Wheels Wagon is the one aut used on trip. It rents for \$99 per w plus 10 cents a mile, without bedding cooking unit (another \$10 a week).

82 POPULAR SCIENCE



port. A short time later, you're enjoying the experience of camping at a site that might be 1,000 miles from home.

ng driving stretches and getting you where you want to go with jet-age speed

tion in four days, and with far less fatigue. And there's another bonus: If we had rented a camper at the same rates at home and driven the distance between New York and Tampa, the expense would have been greater than our round-trip airline tickets!

What I enjoyed most about the ex-

perience was not having to confine myself to nearby familiar campgrounds just because I had only a short amount of time for a camping trip. With the help of space-shortening air travel, I was able to discover camping fun in an area that was new.

The Fly-in/Camp-out program was started in Tampa and Charlotte, N.C., last year. It has been expanded to

include Ft. Lauderdale-Miami, Orlando, and Jacksonville, Fla. These rental points are within easy driving distance of Camp Kennedy, the Everglades, and the Florida sun coast. If you want a camper at the time of a moon launch at Cape Kennedy, though, early reservations are a must.

All over the map. This spring, the rental points have been expanded to include Los Angeles, Lake Tahoe, and Sequoia Park in California, Portland, Ore, Seattle, Wash, and Boston, Mass. Additional cities will have Fly-in/Camp-out units available later in the year. Eventually, a total of 100 cities will have the plan in operation.

If you wish, Camp America will provide you with your first overnight campsite reservation within a short distance of the airport at which you'll land. This permits you to arrive late at your destination and still find a nearby place to park your camper for the night. The company also includes a campground guide, and maps and booklets with suggested tours to help you decide where the best camping and touring areas are within easy driving distance in the area you fly to.

You can purchase a package Flyin/Camp-out tour at any Eastern Airlines ticket office, or from almost any travel agent where you live. We're already planning our next trip.

an rent when you make your air travel reservations



Vinnebago truck camper rents for \$175 per week plus 10 cents a mile. The big unit leeps a family of four; has built-in stove, lefrigerator, sink, and water supply.



Open Road chassis mount is most expensive camper offered under plan—\$297 a week and 10 cents a mile. It provides bunks and luxury—for as many as six campers.



Winnebago motor home is ideal camper for big families; it sleeps eight. The 22-footlong unit rents for \$250 per week and 10 cents per mile, completely equipped.



Travel to the MOON-in

You can visit crater-pocked moonscapes from another world right here in the U.S.

By R.M. WALSH

The two astronauts stood staring over the rim of the crater. The sight was impressive. Thousands of years ago a meteorite had struck here at cosmic speed, releasing energy equivalent to a nuclear explosion. You can visit that same crater; not years from now on a rocket flight to the moon, but this summer in your car. Those astronauts weren't standing on the moon, but at the edge of Meteor Crater in Arizona, one of many "monoscapes" in the U.S.

The same forces that apparently shaped most of the surface of the moon—volcanism and meteorite impact—have also been at work here on earth. Why not consider visiting one of our "lunar" areas on a trip?

Meteor Crater is the world's best known and most thoroughly studied meteoric impact feature. It's in the Petrified Forest-Painted Desert section. Nearly a mile in diameter, the crater is 570 feet deep.

Astronauts have used Meteor Crater as a training laboratory to help them identify similar features on the moon. Apollo 15 is scheduled to land on the Moon's Censorinus, which appears to be a recent—in geological terms—impact crater like Meteor Crater.

Many campgrounds are available in the Kaibab and Coconino National Forests near Flagstaff, or you may want to stop at Meteor Crater on your

Volcanism shaped the stark black landscape in southern Idaho, where Craters of the Moon National Monument is located.

My own camping trip to Craters of the Moon last August coincided with a visit by the crew of Apollo 14. In November, this crew will be going to the moon. Apollo 14 is scheduled to land at Littrow Crater, in a volcanic area which closely resembles Craters of the Moon.

Barren landscape. Around Craters of the Moon, you can climb into steepsided slag cones, hike up black cinder cones, and walk along cracked and buckled lava flows. In places, lava flows have washed away sections of cinder-cone walls, leaving large, isolated blocks cattered about.

When molten lava flowed here, the exterior surface often cooled, leaving tubes or tunnels through the lava beds. The walls of these lava tubes. and the walls of the slag cones, were formed by escaping gases as the lava rapidly cooled. Just like the foam in the walls of a refrigerator, this frothy rock is an excellent insulator. Ice and snow can be found trapped yearround in the tunnels and slag cones. If similar features exist on the moon. some scientists feel that they may have permanently trapped traces of moisture which could be of great value to astronauts in longer-term lunar exploration.

The campground at Craters of the Moon is built on a base of black cinders. But it's not like camping on the moon; trees and shrubbery give the campsites privacy and shade, and the usual National Park Service amenities are provided. In the same volcanic area of the country is Lava Beds National Monument. This is another barren, jumbled landscape, with ice-lined caves, formed by lava flows centuries ago. There is a campground in the park.

Several hundred miles away is Crater Lake National Park, Ore. While the crater here may be moon-like geologically, water and vegetation have made this one of the most beautiful lakes I've seen.

At one time a large volcano, Mt. Mazama, stood here. As eruptions depleted the reservoir of molten rock beneath the mountain, the mountain collapsed in the center, forming a vast crater, or what geologists call a caldera. The caldera is five to six miles wide, and nearly 4,000 feet deep. It is filled with water to a depth of about 2,000 feet, making it one of the world's deepest lakes. A small cone. Wizard Island, juts up through the water, a remnant of an eruption which occurred after the collapse of the peak. We camped at a campground within the park at Crater Lake.

Fire-formed mountains. Years of careful study by astronomers have led them to believe that the scattered lone mountain peaks found on the moon are probably large individual volcanoes of the Vesuvius type. This type of volcano is common in the Cascades. Especially accessible and convenient for campers to visit are Mt. Rainier National Park, in Washington, Mt. Shasta, in the Klamath National Forest in California, and Mt. Lassen, in Lassen Volcanic National Park in California.

Mt. Lassen is particularly interesting, and I found its campground appealingly uncrowded. This "extinct" volcano surprised everyone by erupt-



shows volcanic cones, craters, lava flows.



Lunar-like terrain at Craters of the Moon monument is typified by this pressure ridge.



Camping sites in the Arizona park are selon black cinders, but shrubbery abounds

Your Car

ing early in this century. Gray dust and ash on the slopes of the mountain, and the remains of burnt trees, are the legacy of a series of explosions from 1914 to 1917. But trees and other plants are already making progress in reclaiming the recently scorched earth.

There are two notable cinder cones in the southwest. One is at Sunset Crater National Monument, along U.S. 89 between the Grand Canyon

and Meteor.

Giant cinder cone. One of the largest and most spectacular of the recent cinder cones in the U.S. is at Capulin Mountain National Monument in northeastern New Mexico, off U.S. 64 and 87. From the rim of Capulin Mountain, which can be approached by auto, you can look down into a crater whose floor lies 415 feet below the crest of the rim. Capulin Mountain's campground is also available.

To see some of the most impressive craters on earth, try Hawaii. Ha-leakala National Park, on Maui, is one vast crater. At one time it was probably circular, but heavy tropical rains have eroded it to an irregular shape, about 7½ miles long and 2½ miles wide. It is one of the largest craters on earth. Some 16 cinder cones, with their own smaller craters, spread across the bottom.

On the island of Hawaii are three vast calderas and a chain of smaller craters in Hawaii Volcanoes National Park. Some of these are in states of mild activity so you can safely watch the type of volcanic action that may have formed many of the moon's features long ago.

Zambriske Point, in Death Valley, seems as remote as any point on the moon. Terrain appears lifeless in this aerial view.



Cinder-cone crater at Lassen Volcanic Park is lunar feature you can examine close up. MAY 1970 | 85





Soon short-takeoff-and-landing airliners will target you direct to STOL ports in the very hearts of the big cities

Your STOL-Bus Is Coming!

Any or all of four designs could be first-generation STOL-buses



Sikorsky S-65-200 is a convertiplane with a 79-foot helicopter rotor, small wings, and two turboprop engines. Capacity: 86.

86 POPULAR SCIENCE

French Breguet modified by McDonnell Douglas has four turbo prop engines. All props interconnect for safety if an engine faill

By BEN KOCIVAR

Talk about the revolution in air travel and you usually think bigger and faster. The thrust of the jet age so far has been in the direction of jumbos carrying 500 people, and supersonic transports going two or three times the speed of sound.

But hold on. There's another revolution in the works. We've been watching the fast movers so closely, we haven't seen the low and slow ones

coming up on us.

The big jump in airborne traffic is developing on trips of under 300 miles, many of them between major cities—as in the crowded Northeast Corridor. Commuter airlines grew from about 15 in 1984 to almost 200 last year.

It's no secret that these small planes, added to the rapidly growing number of big airliners, are jamming may of our airports. One answer to airport congestion is a downtown-to-downtown air service. This would consist of STOL—Short-TakeOff-and-Landing—planes and 500-to 2,000-foot runways to serve them.

Portal to portal. Downtown STOL service would do more than relieve the strain on the big metropolitan airports. It would give you better service—taking you right where you want to go instead of setting you down a long taxi ride from the core of the city.

For a while, the hope was helicopters. But they haven't proved economical on trips of more than 50 miles. Larger choppers with greater passenger payloads may yet fill the bill, but for the present it looks as if STOL strips are the answer.

Five years ago, Oscar Bakke, planning chief for the FAA, proposed a downtown STOL strip for New York. It would have replaced some decaying docks on Manhattan's Hudson River



Small STOLs are ready now

Twin Otter de Havilland turboprop carries 18-20 passengers; hundreds are now in use. This version has skis fitted to wheels.

Britten Norman Islander carries nine, has conventional piston engines and fixed gear. Design is light and unusually rugged.



waterfront. Time passed and the spot was chosen instead as the site of a planned giant housing project. But if the New York plan has bogged down, other cities are moving forward.

STOL aboard? A metroport in downtown Houston is expected to be in operation by the end of the year. Chicago, Milwaukee, and Cleveland already have downtown airports that could connect to STOL ports in the immediate area. Los Angeles has approved plans for a downtown STOL port, and the idea is under study in St. Louis and many other cities.

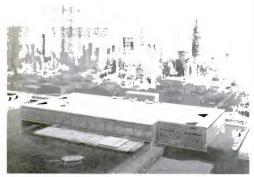
The Civil Aeronautics Board recently concluded hearings on the Northeast Corridor at which airlines, manufacturers, and communities presented their arguments for and against the need and feasibility of metroflight service. The board examiner decided



General Aircraft GAC-100 design is a 36-passenger big brother of famous Helio single-engine STOL. Estimated cost: \$1.5 million.



De Havilland of Canada DHC-7 is a growth version of present Twin Otter already serving commuter airlines all over the world.



Projected STOL port on Hudson River in New York City would have a 2,000-foot

strip atop combined office building and parking facility close to local transit.

that the service was technically feasible, and that by the end of 1973 half the 14 million air passengers between seven northeastern cities could fly by STOL or helicopter.

Airline thinking. Eastern Airlines (developer of the popular no-reservation shuttle runs) and American Airlines have tested a modified French Breguet STOL plane in the congested East Coast and Midwest airspace. The demonstration showed that the metroflight system would improve air traffic somewhat, even when merely using STOL strips at existing airports.

Still, the most promising plan is to separate STOL traffic from conventional planes by establishing downtown STOL ports. Eastern looked at the economics and decided it would rather wait until 100- to 150-passenger STOL craft are built. But Pan Am, another interested carrier, believes the service should start with planes available as soon as possible.

The FAA, remembering what happened to their STOL plans in New York, urges an immediate start, lest land desirable for STOL strips be committed for other purposes. Bakke also believes the pioneering could be done more economically with present small STOLS.

Even a small start, thinks Bakke, would help the already crowded airports and highways. To begin with, existing planes like the de Havilland Twin Otter and the nine-passenger Britten Norman could be used.

To further encourage development of metroflight service, the FAA has suggested to the CAB that an exemption be granted air taxi and commuter operators, presently restricted to craft weighing under 12,500 pounds, loaded. The FAA asked that taxis be permitted to use planes big enough for 50 or 60 people, and still capable of flying from 200-foot runways.

The purpose is plain—it would encourage the design and manufacture of bigger STOL planes.

Pan Am takes a hand. Pan American has surveyed many possible STOL designs and offered a selection of four possible first-generation planes. All are within the present state of the art, and thus could be available in three to five years.

Two are conventional four-engine turboprop STOL craft. The General Aircraft GAC-100 is a low-wing 36passenger plane. The de Havilland DHC-7 is a high-wing 48-passenger plane.

The other two proposed planes--the

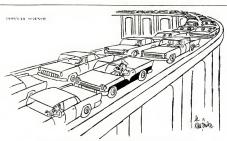
McDonnell Doughas MD-210M and Sikorsky S-65—are aimed primarily at the Northeast Corridor. The MD-210M is a bigger version of the French Breguet. It carries 132 passengers and is unusual in that all four engines and props are interconnected.

The \$65 is a compound helicopter designed for 86 passengers. It uses rotors for vertical lift and has a short wing that helps carry weight when it is flying. It also has two turboprops on the wings, pulling forward. Thus weight is shifted from rotor to wings, and this hybrid can fly faster than regular choppers.

But these craft are in the future. The exciting thing is that STOL planes are available now, and ready to provide the advantages of cheap air transportation that gets you where you want to go, not to some inaccessible airport.

We may well see giant strides in this kind of service this year. It's going to make a big difference in the way people move around. In the bigcity environment, people will hop in and out of town on 100-mile jumps the way they now drive 10 miles in a car. What will it cost? Probably less than flying in conventional planes; in some cases, less than driving and parking costs.

For a businessman, the advantages are obvious. But it could even improve our health through fast movement of specialists wherever they are needed. More interesting is how it will affect shoppers, theatergoers, and the whole cultural scene. In the long run, it may even change the location possibilities for new cities. They will no longer be restricted to sites along a highway system, rail junction, or major river. With true STOL service, cities could be established wherever there is air!



"Captain Odom reporting: Advise passengers on flight 374 of a slight delay in takeoff. I'm stuck in a holding pattern on the turnpike."

The petroleum industry answers Ralph Nader on octane ratings:

"There's More to Gasoline Quality Than Octane Ratings"



By FRANK NEVILLE IKARD

President, American Petroleum Institute

In last month's Popular Science, Ralph Nader, outspoken advocate of consumer rights, argued that the Federal Trade Commission should require gas stations to post octane ratings on the pump ("Why They Should Tell You the Octane Rating of the Gasoline You Buy," April]. Buying higher-octane fuel than your car requires, says Nader, wastes money and creates unnecessary lead pollution. Brand name, claims Nader, is meaningless Major gas companies exchange gas with each other, and sell the same gas to the independent cut-rate stations. If the octane rating of each grade of gasoline were posted, you'd pay only for the octanes your car needs. In this issue, the American Petroleum Institute—the industry's leading organization—answers Raiph Nader.

The research octane rating of a gasoline measures, under laboratory conditions, the relative ability of the fuel to resist detonation—commonly called engine knock. It does nothing more. It does not provide the motorist with information about the overall performance qualities of the gasoline he purchases. Nor does it even indicate a gasoline's actual antiknock capability under the multitude of operating conditions experienced by drivers of the 100 million cars and trucks in the U.S. today.

Nevertheless, the Federal Trade Commission has recently proposed that research octane ratings of gasolines be posted on service-station pumps. The implicit, if not stated, intent of the proposed FTC rule is that the consumer will then be able to select the gasoline his car engine needs to perform satisfactorily, no matter where and how the car is operated.

In commenting on the proposed rule at hearings held last October, Phillips. Myers, a professor of mechanical engineering at the University of Wisconsin, said that "at the best it will provide no useful information to the consumer and will increase, somewhat, the cost of his gasoline. At the worst it will mislead the consumer and increase his gasoline cost markedly."

MISLEADING AND COSTLY

The engineering professor went on to say—as did others from both state agencies and industry who commented on the FTC proposal—that the consumer, with a government-required number prominently posted on the

gasoline pump, would tend to assume two things: first, that the octane rating was the all-important quality characteristic of gasoline; and secondly, that the higher the number the higher the quality. Since higher research octane gasolines generally cost more, the posted number would encourage consumers to buy higher-cost gasoline than they need for their cars.

ESSENTIAL CHARACTERISTICS OF GASOLINE QUALITY

The octane rating is but one of many characteristics essential in judging the quality and performance of a motor fuel. Briefly, other important characteristics include quick enginestarting in cold weather; fast warm-up and smooth acceleration through control of fuel vaporization as the engine temperature rises; vapor-lock protection to prevent the fuel from boiling over in the fuel pump and fuel line; good mileage; minimization of sludge deposit to prevent valves from sticking; and low sulfur content to minimize corrosion and atmospheric pollution.

Every one of these characteristics is essential to a high-performance fuel. No one of them depends on the gasoline's research octane rating. They are important to the consumer in affecting the value of his gasoline dollar and the extent of his enginerepair needs. They also influence the safety and enjoyment he gets from his car's performance.

THE EXTERNAL FACTORS

The presence of these gasoline essentials is not the only reason for questioning, from the viewpoint of the consumer, the value and use of research octane ratings as the criterion for judging the quality of a gasoline. Important external factors can also affect a fuel's performance in an engine. These factors include the speed at which a car is operated (a fuel may knock at a low speed but not at high speed); the temperature of the car engine (a fuel may knock when the engine is hot, but not when it is cool); and the condition of the engine itself.

Altitude and climate can also affect the octane requirement of an engine. Under an octane-posting system, a consumer would find that the same brand of premium gasoline, for example, with a posting of 100 octane in New York City might have a posting of 97 octane in Denver-and yet provide equivalent antiknock performance in both areas. With posting, the motorist would not know that the gasolines, even with different research octane ratings, were made to perform properly and equally satisfactorily under the different temperature and altitude conditions found in various areas of the country.

ENGINE DIFFERENCES

The essential gasoline characteristics, unrelated to antiknock performance, and the external factors that affect engine performance are not the only reasons why posting of research octane numbers would not benefit the consumer. One of the most compelling arguments against the posting of such numbers is that each car engine is different. Engines cannot be built exactly alike. Tests have demonstrated that the octane require-

[Continued on page 126]

MAY 1970 89



The Outrage, new 21-foot Boston Whaler, slides over choppy seas with Jim Roe at the helm. It's powered by a new 85-hp Bearcat.

Testing the New Shipmates:

85-hp, 4-cycle outboard on the Whaler's big brother

By IIM ROE / PS Boating Editor

N ow the 55-hp Bearcat is not alone as the world's only four-cycle outboard—it has a new big-brother Bearcat, with 85 horses.

And the go-anywhere Boston Whalers have a bigger relative, too: the soon-to-be-available 21'4" Boston Whaler Outrage.

Both the Bearcat outboard and the Boston Whaler are manufactured by The Fisher-Pierce Company, at Rockland, Mass. Although built by the same firm, they're not made just for each other. The Bearcat has been designed for any boatman who wants the ease, the sound, and the fuel-economy of a four-cycle power plant. And Boston Whalers have taken kindly to outboard engines of all colors and configurations.

Dick Fisher, host for my test ride, explained that motor and boat were both so new that they weren't production models. The motor was one of the few in existence, and had spent the entire previous week as the guinea pig at a company school for mechanics. And the boat was the prototype from which a mold was made to manufacture more.

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The Outrage. First glance at the boat showed that here was something new: She's big and beautiful, with a sexy curve in the sheer.

Though it's a genuine member of the family, this one bears little resemblance to the familiar Boston Whaler, either below the waterline or above. The center keel is quite pronounced, and the two side stabilizing sponsons ride high, resembling wings. Between center and side keels are three longitudinal strakes similar to those found in a contemporary deep-V bull

Construction techniques on the entire hull, up to deck level, will be identical with that of other Boston Whalers. Above deck level, construction will be of a monocoque type. The transom is specially braced to the hull itself. As a matter of fact, Dick told



Midship control console gives the opencockpit boat its only family resemblance to early Whalers, Day-cruiser models will

probably come along later. The new look includes a sharply curving sheer and steps in the transom to help swimmers board. e, hull and transom could run very icely in almost any weather without

ny upper enclosure at all.

Besides the highly distinctive sweep f the sheer, the Outrage reveals two ther new features: A pair of steps re molded in, one at either side of ne transom, to help swimmers come board. And a series of indentations long each side of the hull add trength and a pleasing look.

The Bearcat, That new 85-horse searcat engine purring away on the ansom in my test ride weighs only 0 pounds more than the original 55p Bearcat-vet delivers exactly 30

p more.

It's a four-cylinder 1,458cc Coveny Climax, made famous in the Lotus ar. It's aluminum, with overhead ams. It has been specially beefed up or sustained marine operation under all load. They've hardened the rankshaft, switched to steel timing ears and Stellite exhaust valves, addd valve rotators, strengthened and engthened main-bearing cap screws.

With a 9:1 compression ratio and win side-draft carburetors, the Bearat produces an honest 85 hp at 5,500 om. And its total gross weight is a nodest 279 pounds.

My test ride. The 85 four-cycle orses gave a highly satisfactory ride. lain, fog, and a cold breeze filled the ir as we hit six-to-nine-foot seas in ne North River Inlet, which was beng whipped by an approaching storm nd a strong flood tide.

Hitting the seas at all angles, and t all speeds including full throttle, he Outrage and the Bearcat 85 howed no concern. Most surprising f all, the hull shape of the Outrage lowed into the steepest and chopiest of the tide rips, time after time, nd let us turn back toward shore ithout once taking a faceful of salt pray. An impressive performance.



ew engine is examined by Dick Fisher and m Roe. It has battery ignition, an alterstor with solid-state regulator.

PERSONAL-USE REPORT

The PA System You Sling **Over Your Shoulder**



Battery pack consists of six D cells,

and should power the unit for about three months of normal use. Panel at rear of the case comes up easily.

VP280 portable PA system is selfcontained and weatherproof. comes ready for use-insert batteries, plug in mike, flip on mike switch. Volume control knob is on outside of case for easy accessibility. Weight of unit: four pounds.

Teachers, camp counselors, tour guides-anyone who has need to be heard loud and clear but whose movements prevent his being tied down to a fixed PA system-will welcome the VP280 portable PA system. The maker claims there's no comparable unit anywhere. I believe him, having looked hard and wide for such a system.

At four pounds, it's not much heavier than a modern reflex camera, and it slings comfortably over your shoulder. The slim, light dynamic microphone slips into the case-or for frequent use can be tucked in your breast pocket.

The mike is highly directional; you have to speak straight into it. But that means also that it doesn't pick up extraneous noises-street sounds and overhead planes. That's a big plus to me, an architectural buff who occasionally leads small groups through noisy city areas.

There are two speakers-one at each end of the carrying case. A switch in the case lets you choose between dual- or single-speaker settings. The dual setting is the normal one. But the single is louder-with all power going into one speaker. A mike switch supplies on-off control.

The voice that emerges from the speakers is clear and distinct, the volume controllable by a knob outside the case. But amplification is limited. This is not a unit for calling over great stretches of water or for reaching the bleachers at your ball

Power for the all-solid-state unit comes from six D cells. In normal use, says the maker, a set should last three months. Changing batteries is simple and fast.

Price: \$69.95 (less batteries). It's made by The VP Company, 330 South Fair Oaks, Pasadena, Calif. 91101-Everett Ortner.

What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS





The world's largest catamaran ferry is now in service betwen Kobe and Takamatsu on Japan's Inland Sea. The 274foot cat has space for 42 heavy trucks, 10 light trucks, 50 cars, and S80 passengers. Cruising speed is 19 knots.



Rock-a-by ramp ★

Drive your car onto this seesaw—the front end is raised for easy access. Want to work under the rear? Drive the car past the point of balance. The front goes down; rear comes up. The idea was conceived by an English landscaper, who claims seesaws are cheaper and easier to use than conventional ramps.



Jumping key ♣

For absent-minded drivers, here's a key case with a brain-Push a button when you risert it. When you turn off your car ignition, the key automatically jumps back into the case—you can't accidentally leave it in the lock. Made in England by Rollite Products, Clarence Dr., Filev. Yorkshire.



★ Car-borne cart

This shopping cart goes everywhere with you: Load it at the supermarket; use it to wheel the groceries into the kitchen. Storage is easy: It fits on rails under the Bertone 128 coupe. Wheels retract; handles fold flat. (The Bertone is based on the Fiat 128.)

Airborne watchdog ➤

A radome mushrooms out of the back of Boeing's design for an Airborne Warning and Control System (AWACS). Radar would detect low-flying enemy aircraft. The phone would serve as a command post for air-defense and tactical forces. Boeing is competing for an Air Force AWACS contract.



Roomful of furniture from a four-foot cube >

Bob Olsen took a four-foot cube of styrofoam and cut it into seven pieces of furniture with 28 different seating sur-

faces. A student at the Parsons School of Design in New York, Olsen created the furniture cube for the Armco Student Design Program.

"I could furnish a small apartment with just the single cube. or an entire outdoor recreational area with a series of cubes." he says. "As soon as you tire

of one configuration, all the pieces can be shifted into new positions." Three cuts through the cube result in pieces to form beds, chairs, stools.

hassocks, lounges, and pillows. The "hard" prototype in styro-foam will be replaced by a soft polyurethane-foam one.



Radar picture

Pilots of Lockheed's new riStar jet liner will get a clear 'view'' of the runway in any eather with an I.L.M .ndependent Landing Monitor n board. The radar device reates an image of airport eatures on the screen. The riStar will begin service te in 1971.



Concept car >

By the mid-'70s cars may have: instruments that spell things out on a screen in red letters, pushbutton combination door and ignition locks, a gauge that flashes the condition of the road surface. Anyway, those are some ideas Chrysler is testing in this Cordoba de Oro.







← Concertina connection

A concertina connection, similar to those between railroad cars, turns this German doctorinventor's station wagon and trailer into a single unit. The pleated connection allows passage from wagon to trailer.

Sailplane power A

A jet engine for \$248? Yup. that's the price of the new Thermo-Jet, a 14-pound engine that burns LPG and delivers 30 pounds' thrust. It's designed to get sailplanes into the air. Two will do the job on most single-seat models, Thermo-Jet, Kerrville, Tex.

What's New







New 180-hp Super-Citroën has front-wheel drive A No warmed-over DS is Citroën's new S. M., but a completely new GT coupe. Naturally, it uses many of the same developments, with refinements. It rides on self-leveling air-and-oil springs, for instance. But the stering is something newvariable ratio, with power assist. But the ratio varies not only with the steering-wheel input but also with the vehicle speed! Engine is a four-overhead-camshaft V6 built by Maserati in Italy. It drives the front wheels through a five-speed manual transmission. Brakes are power disks all around. Top speed is about 120 mph. Price? About \$6,000.

≼ Side controls

Is the pilot's control stick on the way out? It may be if a new system called the dual sidearm controller passes its Air Force tests in a B-26. The new system gives the pilot a better view of the instrument panel, better control of the ship, and is expected to be less tiring to use.



← Family amphibian It used to be an air-cushion

trailer—now it's been converted to an air-cushion amphibian for the family. The steering wheel is right where you'd expect it mounted on the dinette table. Controls are nearby, at the side of a built-in wardrobe. The 14-footer is being tested in England.



→ Weather or not

Neither rain, sleet, nor snow will keep United Air Lines mechanics from diligently maintaining the engines of their Boeing 727s. They'll just inflate this dual-wall fabric shelter and raise it into position under the engine. Inside, they can work in comfort during winter months, when hangar space is scarce.

Cordless corrector >

If you make a lot of mistakes, this cordless electric eraser might be for you. The rechargeable batteries have a built-in provision for quickcharging under heavy erasing conditions. Designed for draftsmen, it uses standard seven-inch round erasers. Pierce Corp., Mound View Rd., River Falls, Wisc.



Lasers a laboratory curiosity?

No more. Now they're
being used to align and to
grade sawers. A new Her-Ne
laser designed for the job
emits a harmless thin ray of
red light. This is lined up
on targets inside the pipes,
eliminating strings, transit
sightings, etc. University,
Labs. Befkelev. Calif. 94710.



What's New IN BOATING





A Drain with a brain

The flapper valve on this drain plug lets bilge water out when your boat's under way. closes automatically when boat stops. You insert the plug into any standard oneinch drain hole. Inside and outside caps double-seal the valve during prolonged wet storage. Tempo Products. 6200 Cochran Rd., Cleveland.

A Plastic navigator

Now from Britain comes a

plastic sextant, the Pilot. It

offers features of standard

sextants at a \$65 price.

Here's what you get: full

seven-inch radius, micrometer drum mounted on

index arm, adjustable two-

power telescope. Coast Navi-



White-water canoe A

Adventurers-now you can ride the rapids first class with a buddy for company. Old Town's two-man Berrigan canoe is a sandwich of end-grain balsa and plastic, so strong it doesn't need ribs. The 16-foot, 63-pound canoe has bow and stern cockpits, plus a center cargo hatch.



It's a waterborne version of the old porch swing. There's room for just two on the padded vinyl seat shaded by a surrey top. A four-horse engine turns the sternwheel; forward and reverse gears provide maneuverability. The fiberglass "Puppy Love" is made by Lovecraft Boats. Holland, Mich. 49423.



Marine burglar alarm ➤

This marine burglar alarm takes a hard line on thieves. The line, a 25-foot nylon rope, connects directly to the alarm control center. With your boat secured by the line, attempts to unfasten it-by cutting it or opening the eye hook-triggers the alarm. International Patents and Development Corp., Kings Point, N.Y.



Two-man dory >

Always a popular boat in rough coastal waters, the dory promises to become even more popular in this 20-foot fiberglass form. A six-foot beam gives it good stability; narrow ends help it ride the surf. Comes with or without motor well. W. D. Schock Co., 3502 S. Greenville St., Santa Ana, Calif. 92704.



★ Ever-level stove

No matter what the weather, the Sea Swing marine stove stays level. It's a gimbalsmounted adaptation of a Ronson butane burner, ideal for cooking in sailboats. even at steep heel angles. You recharge the fuel supply with butane injectors. Paragon Productions, 191 Brady La., Bloomfield, Mich. 48013.



What's New IN ELECTRONICS



♠ Wearable stereo

Convenience, comfort, quality sound-that's what GE's new stereo headphones give you. For convenience; color-coded channel identification. For comfort: inflatable headband. For quality sound: a frequency range from 20-17,000 Hz. The eight-ohm phones are suitable for all phones with headphone jacks. \$20.



Camera + recorder + monitor = instant replay A Combine a GBC TV camera, a Sony receiver/monitor, and a video tape recorder. What have you got? The lowest-priced video record/playback system ever offered. At \$595, the combo is about half the price of other record/playback systems. GBC's VR-50 package can tape broadcasts off the air, or pick up from the automatic-exposure-controlled camera. Add a microphone, and you get fully synchronized sound, monitored during recording, for perfect results. GBC Closed Circuit TV Corp., 74 Fifth Ave., New York, N.Y. 10011.





A Concert-hall sound for your home

How do you cram big music-hall sound into a living room? One way is with these four-channel units: the Wollensak Quad/Stereo deck and the Scott 499 Quadrant amplifier, above. Together they play four-channel tapes through four speakers. Two in front of you provide stereo music from the "stage." Two more behind you give the spacious sounds of reverberations from the back of the hall. The model 6154 quadrasonic deck is \$500. Another \$600 gets you the amplifier. Let's see, that just leaves the matter of the four speakers . . .



→ Big inch

Electronic components overheating? Micro-Kool, a tiny blower less than an inch in diameter, will move almost six cu. ft. of air a minute to cool power transformers, resistors, any point source of heat. A 6-VDC motor turns the fan. HICO, E. Fuller at Middlefield Rd., Redwood City, Calif. 94063.



Two-way traveler A

Light sleeper? Set the Realistic clock radio to wake you with soft music. Heavy sleeper? Set the buzzer, tooif the music doesn't wake you in nine minutes, a buzzer sounds. The package folds shut for traveling, with space for lewelry, etc. Four AA cells provide power. \$19.95 from Radio Shack stores.

What's New FOR YOUR CAR

Thaw blades a

Here's a system to take car of next winter's ice and sno -wiper blades that are heated Blades are made of a silicone based elastomer that heat to 380 degrees F in fiv seconds. Price; \$29.95 t \$39.95 per set. Comstoo Tool & Electric Co., 875 Con stock, Los Angeles 90024



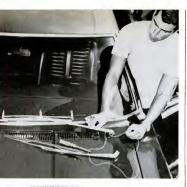
Rear defogger No factory-installed rea window defogger? Here's or

that goes on the rear ded without obstructing vision. comes with 25 feet of wire mounting clamps, an instructions. Fits all 12-vo systems. Installation's simple \$9.95 from Regal Enterprise 1750 W. Jarvi Chicago, III. 6062



Wheel wedge

This plastic wheel wedge or chock is designed grip both the tire trea and the ground it's standing on. It fits all tire sizes. suitable for cars, pickup campers, and boat trailer \$2.75 each from Batiki Box 231, Radio City Sta New York, N.Y. 1001







Built-in power ectric power for accessories tools is what the Statron ves you, whether your car running or standing still. fits under the hood, is belt-

iven, generates up to 3.5 /A at 60 cycles, 115/220 Its. Automatic Radio. elrose, Mass, 02176.

♠ Battery connector

There's no battery-post distortion, no gaps to collect moisture, with this connector. The stainless-steel bar hooks grip with equal pressure around any size post. \$1.35 from Thomas Engineered Products Box 1144 Williamsport, Pa. 17701.



Protection from music-loving burglars

ne tape player in your car will be a lot safer with plen's new 200 security lock. Even if burglars should et inside your car, they'll have a hard time and ed professional equipment to detach your stereo set om its mounting once it's protected by this seven-pin mbler lock. The device is both free-spinning and rench-resistant. The owner has one of 25,000 key mbinations, which adds a high degree of pick-resistance. 0.95 from Bolen Industries, 789 Main Street, ackensack, N.J. 07601.

What's New IN TOOLS



V for victory over drawing problems A

The Proportional V:Scale is a boon to draftsmen and home craftsmen. It quickly enlarges or reduces drawings, plans, and models, providing one-step scaling without intermediate measuring. Use it as an inside or outside caliper when rescaling models or sculpture. Or reproportion graphs and charts. Use it against a straightedge for dividing spaces into percentages or fractions-horizontally or vertically. Find the centers of lines, spaces, and circles. Construct ellipses by the foci method. Use it as a protractor or to find trig functions of unknown angles. \$2,25 from GraphiCraft, Box 509, Westport, Conn. 06880.



♣ Speed control

All your power hand tools have variable-speed motors when you plug them into the new Dremel motor-speed control. Just dial from 0 to full speed-slow for driving screws with hand drills, or saber-sawing hard metals; fast for drilling woods. (Makes a good light dimmer, and controls soldering irons, too.)

A Dial-a-depth

workshop jointer Rockwell Delta's new six-inch jointer has a quick-action depth-of-cut control with a calibrated scale for simplified adjustment of the large 61/a-by-351/a-inch table. Other features include a cen ter-mounted fence that tilts 45 degrees left and right, with a positive stop at 90 degrees. The sealed ball-bearing cutterhead is completely guarded at all times for increased safety. With recommended motor, it delivers 12,600 cuts per minute. Price: \$169.50 with three high-speed steel knives, cutterhead pulley, and safety guard. Motor, V-belt. stand, and dust chute are available at extra cost.

What's New IN HOME IMPROVEMENT

Is this flooring a fraud?>

Though it looks and feels like carpet, it's actually a seamless cushioned vinvl that Armstrong calls Easy Street. It's for those who want kitchen carnet without the spill problem of a fiber type. The foam-backed material has a nonporous surface, wipes clean. Comes in 12-foot rolls for one-piece installation; three patterns.



←Up, up, and around: New aluminum staircase

You can get to the top in style with this new aluminum spiral staircase. It adapts easily to fit almost any home. It comes in fourand six-foot diameters; in right- or left-hand entry: in sizes to fit almost any ceiling: with tread inserts of either wood, carpet, or vinyl, Aluminum parts are primed in white, can be painted to match any interior. A vinyltopped handrail adds strength, safety, and beauty to the design. Columns, Inc., Box 12345. Houston, Tex. 77017.



Cover-all A

Flexion coating adheres to wood, stucco, roofing, metal. etc., providing a tough waterproof finish. Compounded of nylon, epoxy, and silicones, it comes in oneor five-gallon sizes, can be tinted. Flexco of Florida. 2529 Okeechobee Rd., Ft. Pierce, Fla. 33450.



▲ Two-coat color

Tired of the dismal gray cinderblock walls in your basement? Two coats of PPG's new Pitt-Glaze will turn those walls into bright, tilelike surfaces. The first coat is a high-solids filler-primer, the second a pigmented topcoat available in 90 colors.



▲ Shaped carpet tiles

Now you can get carpet tiles in a Moorish design as well as in squares. New VersaTiles have a self-sticking back. so they're easy to install, easy to replace if damaged. The fiber face is guaranteed for three years against wear and rot. They're made in solid and printed colors by Tile Co. of America.



A Easy-see board

An aluminum blackboard? That's right, the surface is anodized to a deep black finish that gives greater legibility, and easier cleaning. Sizes run up to four-by-12 feet, framed with aluminum moldings. Fairgate Rule Co., Cold Spring, N.Y. 10516.



A Lightweight dryer

Great for vacation homes, this portable dryer delivers drip-dry shirts wrinkle-free in under an hour. The little 111/2-pound unit handles two pounds of damp wash. combining 660 watt heating with a gentle tumbling action. It's \$24.95 from Wagner Products Corp., Milwaukee, Wisc. 53209.

What's New

FOR THE YARD

A Come and get it!

That neatly folded package above opens up into a barbecue cart with two 24-by-18 steel shelves and six clips for hanging utensils. You roll it out to the grill on large rubber casters. It's \$22.95 from Habney's, 261 Huntington Ave., Buffalo, N.Y. 14214.

Margin of safety for your pool >

Nerak coping provides a ribbed-plastic no-slip margin of safety around a pool. You install mounting plates with simple hand tools and snap the sections in place. The white Tenite polyethylene coping comes in four-, six-, and eight-inch widths; and in straight, curved, and corner sections. It can be used on pools with concrete (block. poured, or Gunite), steel, or wood walls. GFA Products, Box 22, Fairport, N.Y. 14450.



A For problem lawns

Sears' new sprinkler hose puts the water where you want it. Five guides packed with the 50-foot hose let you angle the spray to one side or the other. A shut-off clamp located anywhere along the hose "shortens" it to spray small areas. It's great for foundation plantings, flower beds, narrow sections of lawn.



A Astro-surf in your swimming pool?

This plastic cover is to a swimming pool what the Astro-Dome is to Houston's ball park. It traps the sun's heat, keeping your pool, and you, warm from early March into October. Lets you start the swimming season early, finish late. The vinyl cover inflates in about 20 minutes with a multispeed blower provided. It's held in place by an ingenious water-filled border around the bottom that doubles as an air seal. You enter the dome through a zippered door. Sylvan Pools, Route 661, Bucks County, Doylestown, Pa. 18901.





Little worker in a long line of tractors A

A new entry in the International Harvester line of lawn and garden tractors is the six-hp Cadet 60 riding mower. The versatile machine has a center-mounted 32-inch reardischarge rotary mower, and takes a lawn sweeper and snow thrower. The four-speed transmission gives full forward and reverse without changing gears. The Cadet 60 is a little brother to the Cub Cadet garden tractors, popular with nurserymen and home owners. Cub Cadets come in 10-, 12-, and 14-horse models, and take a variety of front- and rear-mounted attachments as well as center-mounted mowers.



Extras: Audio Cube (left) synchs tape recorder; Time Cube is for auto cycling.



Slide Cube cover opens as cube is slid in place, permitting slides to drop.



Control panel with cord slips out (on top models) for remote use.



Tilt-control knob elevates lens up to 20 degrees and adjusts mirror angle.



Previewer shows slide coming up, can be used to feed slides into machine. 100 | POPULAR SCIENCE

PERSONAL-USE REPORT CUBE PROJECTOR: Answer to the Slide-Storage Problem

Everything's coming up cubes in Bell & Howell's new slide projectors—not only the projectors, but the slide "trays," too. The latter are, really, not trays at all but cube-shaped containers about 2½ inches on a sidenot much bigger than the stack of 40 slides they hold.

Naturally, everything's automatic. Insert a Slide Cube cartridge and press the cycle button. A horizontal merry-go-round starts up. Onto it drop the slides, to be carried past a previewer, so you can see what's coming up (or reject it before showing), then on to the projection position, finally to a collection chamber. When all 40 slides have been shown, you lift a lever that returns the slides to the cartridge. Want to find a particular slide? Hold the cycle button down; slides pass through the system, visible only on the previewer, until you spot the one you want. Time for 40 slides: 30 seconds.

Raising the projection angle is easy: The lens tilts—not the machine.

There are four models, all with quartz-halogen lamps. Prices, depending on such features as zoom lens, automatic focus, etc., are \$112.50 to \$184.50—Everett H. Ortner

Those

Shop-test report on the new tungsten-carbide saw blades: smooth cutting, do-everything versatile, 10-to-1 durable

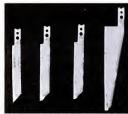
By R. I. DeCRISTOFORO

Some years ago Disston sent me a 50-tooth, tungsten-carbide-tipped circular-saw blade that is a real spoiler. It sits on the machine for months and months cutting hard materials, soft materials, and abrasive materials, and has just about made obsolete all the other blades in my shop.

Performance like this engenders respect for the material that makes it possible, so any tungsten-carbide-tipped cutter that comes along is bound to attract my interest. I just finished testing some new entries in the cutanything, "last-forever" field that are as impressive as my pet, but they do differ in concept—with almost a file's relationship to a saw blade. I'm talking about the revolutionary new Remington tungsten-carbide blades, first introduced for industrial use, now being made available for home work-shoppers.

My circular blade has teeth; the new wonders do not. Instead, the cutting edges consist of hundreds of particles of tungsten-carbide granules fused to the blade material.

Tuting speed isn't the name of the game: A bunch of teeth will chew out more material than a line of grit and, generally, do it faster. Judged under home-workshop conditions, this suggests that the toothless blades do not—probably aren't meant to—replace comparable toothed ones. But they do provide a valuable supplement.



Saber-saw blades include fine, medium, and coarse grits, and flush-cut type. They cost \$2 to \$2.50, but can outlast regular toothed blades as much as 10 to one.

ncredible Toothless Saw Blades

What saber-saw blade or bandsaw blade do you own that can cut easily through ceramic tile or slate, or through unsandwiched sheet metal, without excessive burring and edgelifting?

Comparing speeds. The blades, both step and band, work fine on wood. They leave an impressive, almost sanded, edge with minimal splintering and feathering. They do not, however, cut as fast as conventional blades.

A medium-grit tungsten saber-saw blade took about 50 seconds to make a 10° cut through ¾." DF plywood. A 10-tooth-per-inch, taper-back blade made it in about 19 seconds. A seventooth-per-inch blade with set teeth ran the 10° in about 14 seconds. There was, however, a big difference in cut quality. Although the taperback blade (designed for the purpose) left a respectable edge, the tungsten blade came out on top.

On the bandsaw, a 24" cut through 3/4" DF plywood took about 25 seconds with a 3/2" medium-grit tungsten blade. The same cut with a conventional 3/4" toothed blade took about 12 seconds. But again, the toothless blade made the smoother cut.

These tests were not made under instrument-controlled conditions, but feed was meant to keep each blade cutting smoothly without forcing, which is the way you will work. So, when working with wood, if you want to make some sacrifice in speed to get cut quality, the toothless blades are a good choice.

They are also a good choice when cutting hard metals. It took about 92 seconds to go through a 1½"-OD heavy-walled steel tube with a 32-tooth wave-set saber-saw blade. With a coarse-grit tungsten blade, it took about 80 seconds. Not a great difference in time, but results were startling as far as durability is concerned. The conventional blade was obviously tired after the job, while the toothless blade was ready to repeat the chore many times over.

The durability factor applies to the toothless blades generally. There is no question that they will outlast conventional blades by a most impressive margin.

In some cases in the home workshort between the too the comparison with conventional blades. The toothless ones will cut ceramic tile, slate, asbestos cement, clay pipe, brick, stainless steel, counter-top material, and many other similar problem materials.

[Continued on page 129]



Tungsten-carbide toothless wonders do jobs that would run a regular blade—like cutting through nailed-down hardwood flooring. Coarse-grit blade works best here. Right, business end shows particles (used to blade metal. Blade cuts on both up and down strokes.

Take your choice: rod saw, saber saw, or bandsaw



Blades available are shown above. All of them cut a fantastic range of material. At left, rod blade goes through ceramic tile. In center, with plywood used only for support, saber-saw blade cuts through thin sheet metal. Cut is almost free of burrs. At right: Bandsaw produces a slick cut in chip-prone counter topping.

They're slower, but slick-cutting and amazingly durable



Speed tests show that tungsten blades are slower than conventional blades—but (center) produce smoothest cut. Compare with edge produced by fine-tooth, taper-back

blade in center. Right, "hacksaw" sabersaw blade shows tooth wear after going through heavy-walled steel tube. Tungstencarbide blade looks like new.

Those New MIRACLE CURES

They'll restore your craft to like-new condition, or convert a rundown bargain into a reliable dreamboat

By GEORGE DANIELS

Looking for used-boat bargains or a longer life for your wooden craft? A shelfful of amazing new chemicals will seal leaky seams, harden rotted planks, patch torn canvas, replace peeling paint, even repair engines. Though most are designed for wood boats, many will work for you just as well on fiberglass.

If you're skillful enough to read a label, you can do repairs the experts once found impossible—often in record time. All but a few of the cans, bottles, or tubes you'll need are at your marine dealer. The others are so new you must order them direct from their makers; a listing at the end of this article gives names and addresses.

Curing a sick boat. To show how it's done, let's assume you've spotted an aging 30-foot cruiser that looks like a hopeless wreck but could be a great bargain. Her open seams gape between shrunken planking. Blotches

of soft rot discolor the keel, where paint has flaked off. A battered dinghy, its fiberglass hull faded from the weather, dangles from its davits.

You hoist yourself gingerly onto the afterdeck, gripping corroded awning supports. Overhead, the canvas is ripped from end to end. Through an open hatch in the cockpit floor you peer down at oil-soaked planking, a cracked frame, a husky marine engine with controls locked in rust and a chunk of its carburetor lying in the bilge.

Forward, through a partly delaminated plywood door, you see the once-luxurious main cabin. Seat cushions are threadbare and shabby. Walls are a mass of peeling paint streaked with dirt and rust from the leaking cabin roof, windshield, and port lights.

Hopeless? Not at all. With those wonder chemicals and a few tools you can cure every trouble mentioned and many that were not. Some are quick jobs that take minutes, others can be done in hours; all are possible in time for the cruising season.

Quickie cures. Let's start with the quick ones. You uncover the upper ends of the tubular awning supports and pour in a variable-density foam mix. It's so new you still must order it direct from the manufacturer. Like

older foam-ins, it sticks to almost anything; but unlike them, it allows five minutes' working time between mixing and foam-up, lets you regulate its density (and strength) by the amount of water you add.

You can mold Varifoam into mooring floats and fenders, too, using Butcher's wax or Johnson's paste wax

as a parting compound.

Next, you pick out a new superstrength adhesive to glue on the cracked carburetor piece. Acrylics like 3-Ton Adhesive and P.A.C. can be mixed for slow or fast setting-they?!! harden in as little as five minutes with a hefty bonding strength of 6,000 p.s.i. A cracked diesel crankcase re-

paired with 3-Ton was still in service five years later.

Or you could use a fast-acting epoxy, like Ten-Set, that locks up to a strength of nearly a ton per square inch in 10 minutes. It bonds to almost any boat material, not just metal. Epoxy adhesives fill chipped-out areas in shattered breaks and are unaffected

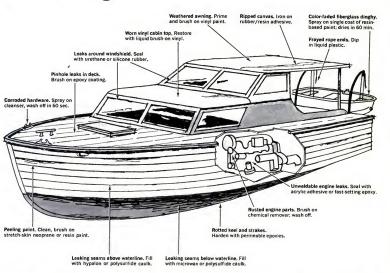
by water, gasoline, or oil.

Strengthening that cracked frame near the engine calls for one of the new epoxies that stick to oily wood or metal surfaces. You remove as much of the oil as possible with solvent and a detergent solution, then

[Continued on page 140]

GUIDE TO MIRACLE MEDICINES FOR BOATS				
TREATMENT	PRODUCT EXAMPLES	COMMENTS	TYPICAL PRICES	
Gluing, vary fast set, very strong. Water-, oil-, and gasolina-proof on wood, metal, or fiberglass.	3-Ton adhesive, P.A.C. adhesive, Both two-part acrylics. Set-time as short as five minutes. Strength to 6,000 psl.	Set-time can be regulated by varying proportions of the two components, Also stops rivet leaks in metal hulls.	\$4.20 per ½ pt.	
Gluing, emargency or spot rapairs, with- out mix-measuring. Same durability and fast set as abova. Moderately strong.	Ten-Set epoxy, set-time 10 minutes, strength approaching one ton psl.	Available in premeasured Pop Pack containing two components in partitioned mixing cup. Also stops rivet leaks in metal hulls.	\$1.09 per four-gram package	
Gluing, eily surfaces, wood or metal. Overnight set.	Hysol EA 913, quarts and larger. Miller- Stephenson twin-tube 907 adhesive for small jobs. Both are epoxies.	Two-part types are applied after cleaning parts as well as possible. Glue mixes with remaining oil residue, then hardens.	\$13 per qt. for Hysoi EA 913 \$2.50 per four-ounce kit of M3 907. (Minimum four kits).	
Gluing, major repairs an wood, Allows ample working time.	Weldwood resorcinol resin glue, Elmer's boat glue.	Two-part resorcinol types. Overnight hardening at room temperature. Stronger than the wood.	\$5.95 per qt, for Weldwood resorcinol. Less in gallons Elmer's comparable,	
Restoring rettad weed, relaminating ply- wood, firming loosa fastanings. Water- oil-, and gasoline-proof.	Calignum, Git Rot, End Rot, Rot Not. Two- part permeating epoxies or combinations containing epoxy.	Soak into rotted wood (like resins soaking into fiberglass fabric), harden to produce a dense, high-strength combination. Stronger than wood.	\$8.95 per pt. for Calignum Others comparable.	
Caulking wide seams for peak strength to flex with working hull. Above or below waterline.	Sav-Cote polysulphide seam compound, Calahan's hypalon (Seaprene) seam com- pound.	Compounds bond to wood and cure to form strong, thoroughly flexible (and stretchable) seal.	\$5 for one-lb, gun cartridge o Seaprene. \$7 per pt, for Sav Cote.	
Caulking wide seams below waterline enly. Can be applied to wet surfaces. Flexible.	Silck Seam compound. Made of micro- crystaline waxes, hydrous magnesium silicate fibers. Jells in minutes for quick, conventional painting.	Applies easily without priming or mixing. Never becomes brittle, can be pushed back into seams if it works loose. Sun's heat softens; can't be used topside.	\$2.95 per pt., higher on Wes Coast.	
Sealing pintele leaks above or below waterline where laak detaction is diffi- cult,	Fibreglass-Evercoat Seal It, two-part epoxy coating.	Brush-on coating bridges slow-drip seams and gaps to 1/100". Sets overnight; reaches full strength in three days.	\$5.95 per qt. Similar product comparable.	
Filling gouges and digs in hull or cabin. Quick-drying for same-day painting or fiberglassing.	Formula 27 plastic filler (Fibreglass- Evercoat Co.). Two-part polyester putty.	Resin-and-hardener putty. Can be sanded 20 minutes after application. Waterproof, white. Used like conventional putty.	\$1.85 per ½-pt.	

for Ailing Wooden Boats



TREATMENT	PRODUCT EXAMPLES	COMMENTS	TYPICAL PRICES
epairing fabric and sails.	Patchstix, multi-resin adhesive, Water- proof and completely flexible.	Brushed on, turns to rubber when repaired area is heated with a flatiron. On heat-sensitive fabrics, allow to dry without ironing.	\$5.75 per gal.
estering vinyl fabrics, vinylizing canvas.	Recoatit vinyl coating and Sav-Cote spray ename! (vinyl acrylic). Both flexible, waterproof.	Can be used on weathered cushions, cabin tops, other vinyl-fabric surfaces. Produces luster finish. For canvas, Recoatit needs canvas primer.	\$4 per pt. for Recoatit,
ealing windshields, windows, porthole lass.	Marine Construction Sealant (urethane by Dow Corning) if seal will be painted; silicone-rubber sealant otherwise.	Applied from tube, both types adhere to most materials. Waterproof, flexible. Urethane type needs paint if in sunlight. Silicone rubber doesn't need or take paint.	\$5 for caulking-gun cartridge of silicone rubber, \$3.35 for polyurethane.
temoving rust.	Rust Away (MDR Corp.) and Naval Jelly (Woodhill Chemical).	Brushed on, left for working time specified, washed off with water. Clears light rust in minutes. Must be reapplied for heavy rust.	\$2 for eight oz. (liquid) of Rus Away. \$1.50 for equal amoun of Naval Jelly.
emoving corresion from brass, chrome, luminum.	ABC metal cleanser (MDR Corp.), Works in 30 to 60 seconds.	Brush or spray on, wash off with water.	\$2.98 for eight oz.
estoring windshields, worn or scratched lastic	Windshield Caddy (N. A. Taylor Co.). Kuhis Scratch Remover for plastic wind- shields.	Caddy is complete kit — compound, applicator, polishing pad. Kuhls is compound only.	\$2.75 for Caddy, \$1.40 for Kuhls.
ainting for same-day launching of small oats	Evercoat Fibreglass Spray Paint, white only, for wood, steel, aluminum, fiber-glass.	Covers in one coat, sprays at temperatures as low as 30 degrees. Tack-free in 10 minutes, ready for launching in one hour.	\$2.75 per spray can (one pt.)
ainting old planked hulls with seams hat work when hull twiats in seaway.	Sav-Cote, Seaprene, Rub-R-Cote.	These coatings form an elastic skin that stretches and contracts with seam movement between planks, Should be used with specified caulkings,	\$4.95 per qt, for most brands
retecting high polish on hardware.	Kuhls Clear Coating high-gloss spray.	Sprays on all polished metals. Dries in five min- utes, prevents corrosion.	\$2.10 per spray can (12½ oz.)
tiffening tubing.	Varifoam	Two-part foam-in mix. Allows five minutes work- ing time, Density can be regulated by varying amount of water. Can be used as tube fill for stiffening.	\$6 per gal,

Taking Care of Your Car

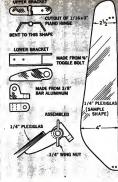
Good hints others have used

Got a car tip? We pay \$25 for each one accepted. Send it to Car Care, Popular Science, 355 Lexington Ave., New York, N.Y. 10017.



Bend-over locking tabs on manifold bolts work perfectly, but they're hard to straighten when you want to remove the bolts. Solution: Grind a taper on the edge of a deep socket, tap it over the bolt.

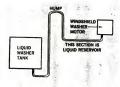




New cars that Lack vent windows are bad news for motorists who drive with their windows down. If you're one of these, make a set of vents from Plexiglas. Use aluminum stock to make brackets, with wingnuts to lock vents in position. Attach the brackets to the car with two screws that secure the body molding in front of the door. Cut Plexiglas triangles that will swing inside the car when you want to close the window.



Bleeding your brake lines? Bleed the master cylinder first and you'll have less air to bleed at the wheels. While a helper depresses the brake pedal, loosen the cylinder's tubing nut to let the air escape. Retighten, then release the pedal



Windshield washer systems often won't pump without priming if allowed to run dynstall a longer hose, with a hump in it as shown. This will act like a sink trap, preventing the hose from draining, and keeping the washer pump constantly primed.



Troubled by a persistent leak at a flared fitting in your car's fuel line? Try this: Twist a ring of thin copper wire around the tubing as shown, and retighten the connection. The concentrated pressure bearing on the wire should seal the leak.



Thread a spare tube nut into the threaded opening when removing and replacing hydraulic-brake angle fittings. This will protect the fitting, preventing its collapse from the force of the wrench. Do not overtighten the fittings when you're replacing them.

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Ine noses of your cars PLV system need periodic cleaning to maintain the engine, when the pit conform with anti-pollution laws, and to meet the terms of your new-car warranty. Nip apart a coat hanger and straighten it out, but don't worry about the kinks. Form a crank in one end, and shove the write through the hoses, cranking as you go. The kinks will scrape out accumulated goo and sludge. After a few passes, rinse the hoses with kerosene or fuel oil, install a new PCV valve, and reassemble the system.

Two Slick Ways to Cut Wood

By E. F. LINDSLEY/PS Outdoor Power Equipment Editor

CROUCHLESS BRUSH CUTTER

Cutting brush from a crouch, with a chain saw designed for heavier work, can be an awkward and even dangerous job. But now the Rowco Brushking adapts your saw to cut brush quickly and safely—while you stand comfortably instead of crouching in an awkward position.

I tested one of these new brushcutters early last winter. It botted to my Pioneer Holiday (adapters are available for most popular saws), replacing the chain bar and sprocket. A throttle wire hooked to the butterfly lever gives control of the gas from the handgrip on the cutter's extension shaft. The whole installation took about 15 minutes, and soon I was out clearing a thicket near my home.

Cutting is amazingly fast. The 10inch "slasher" blade could snick off a sapling in a flash. The results were just as good thinning out overgrown hedges and rough-shaping ornamental growths.

About the only problem was getting the shoulder sling adjusted. A little experimenting showed it worked best to let the sling carry the weight while





Chain bar and sprocket are replaced by three-hole clutch drum that receives three-pin shaft drive. Chain-bar studs secure cutter.

Ten-inch blade, powered by chain-saw motor, goes through base of sapling in seconds. Adapter will also take grass edgers.

your arms control the cutter swing.

The cutter head swivels a full 270
degrees. This allows for both vertical
and horizontal cuts, with a full range
of canting in between. It also lets you
rotate the blade off the ground, safely
supported on the gear head for starting and warming up.

For the chain-saw owner who wants a powerful tool to handle the awkward job of brush cutting, the Brushking can't be beat. Price is \$99.95. Adapters run from \$11 to \$14, depending on the type of chain saw you are adapting. Rowco Mfg. Co., 48 Emerald St. Keene. N.H.

VIBRATIONLESS CHAIN SAW

Lumbermen have long been acquainted with chain-saw vibration, and many a weekend woodcutter has found that it makes for
swollen, itchy hands and trembling
arms. The new McCulloch CP-55
promises to eliminate this fatiguing
problem. After testing one, I have no
doubt the promise is made good.

The idea behind the new saw is to isolate the vibrations of the engine and chain from the handle. McCulloch uses five rubber-cushion mounts between the handle and power frame to achieve the effect.

The saw is intended for man-sized jobs. It has a 3.3-cubic-inch engine and will take bars up to 28 inches. It impressed me as an ideal size for the home owner who cuts medium-size trees and firewood. I found it would slice through 10-inch wet elm logs in about six seconds under its own weight. Heavy pressure won't stall the engine but will drop out the clutch.



Soft-rubber mount—one of five—keeps engine and blade vibration from getting to handle section of saw, and to your hands.

The CP-55 has automatic chain oiling with manual assist right at your thumb if you need it for heavy going. Most occasional chain-saw users tend to forget to thumb the oiler when cutting gets interesting. The additional cost of auto-oiling is well worth it in longer bar and chain life.

Weight is average for saws this size -13 pounds (less bar). \$259.95.

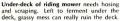


McCulloch CP-55 can slice through a wet elm log in about six seconds under its own weight. It runs on a 40:1 gas/oil mix.

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Do these jobs each week





Once-a-week removal, after mowing, is a good idea. Some new walkers have hose port on deck top to ease cleaning.



This electric mower may need adjustment of belts to specific tension. Such details affect mower life and performance.

It pays off! Follow this year-round repair and maintenance program for **KEEPING YOUR**

Push 'em, ride 'em, or walk behind 'em-one thing about all power mowers: Sooner or later you must fix 'em. The best trick: Do routine fixing on an orderly basis and you postpone serious fixing as long as possible. Mowers need special attention because they lead a hard life.

 Jolting and chopping right down where dirt and dust are worst takes a heavy toll.

 Mowing is seasonal; off-season storage can wreak havoc.

· Wife, children, and any stranger

who can be so induced, operate the mower. Abuse is normal.

 Mowers are sold in an intensely competitive consumer market. Price is often king.

Most new mowers, be they tractor, rider, self-propelled, or push, will operate one season without much maintenance; few will run for two without a going over. Three can be curtains.

Presuming you're less than a speckwiping fuss-pot about your mower, but still mindful of a fair investment and annoved when the darn thing lets you down, what can be done to keep your mower running longer?

New mowers. There are certain facts to remember when a mower is delivered. Your dealer probably received it knocked down. The basic units were assembled on a production line and are subject to the sins and omissions of high production. The man who puts it together at the dealership may be pushed for time and faced with such a variety of makes and models that he isn't expert on any. Hence, program number one:

Adjust cutting height to suit the season



Cutter height is important—usually low in spring, high in summer, low in fall is best. Measure cutter blade relative to deck edge, 106 | POPULAR SCIENCE

then establish actual cutting height versus lift handle position. Tape or paint on marks as a handy guide to proper lift position.



Cutting height measurements on hard surface may not be accurate on turf. Pick a level spot, recheck height against markings.



Checking oil level, greasing or oiling wheels, rollers, and drives, adding battery water are once-a-week checks for a tractor.



Self-propelled rotary mowers need adjustment of such details as the drive release and engagement. Here, drive pulley flange is be-

ing taken up to increase the ground speed. Also remember to keep the handle set where you're most comfortable.

MOWER ON THE GO By E.F. LINDSLEY PS Outdoor Power Equipment Editor

 Go over the mower with a finetooth comb for loose or missing nuts, bolts, and cotters. Check for loose drain plugs, loose cutter blades, and full supply of lubricants, and battery water where required.

 While all is clean and fresh, inspect belt tighteners, drive chains, cutter heights, and throttle linkages. Adjust fuel-mixture needles, seat positions, and handle positions to suit you. Go by the book.

 Right in the beginning work out what you need in oil funnels, fuel spouts, props to let you work on the bottom side safely and conveniently.

 Write down belt numbers, engine and model numbers. Make sketches of belt rigging. Take Polaroid shots of complex belt and idler assemblies for future reference.

 Take a compression reading and record it. Set up a file with all of your reference data and sketches.

If all this seems a drag and you end up adjusting nothing, you've still gained knowledge of your mower that will be useful later. At worst, vou'll have a record of belt numbers before they wear off the belts.

A word about belts. It's worthwhile to lay in a spare or two. Try to avoid buying those displayed on your friendly garageman's hooks. Try to buy the specific belt for the model machine you have from the authorized dealer for that mower. The difference in cost is usually zero, but the difference in

Points to remember about engine repair



If flywheel has puller holes, invest in puller. If not, back off nut flush with shaft end, hit



Notch in flywheel rim is engaged by screwdriver braced on case to remove magneto nut. Never hold flywheel by cooling blades.



Greatest cause of mag-point problems is oil leaking past shaft seal. Use good solvent to brush out oil in breaker housing.



Be sure contacts on new points meet squarely. Place breaker foot on high point of cam, set point gap with a wire gauge.

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Important jobs you should do at mid-season



Change the oil: Here, a pipe nipple extension installed in the original drain hole makes oil draining a lot less messy.



Resharpen blade: Rebalance by pivoting on nail or suspending it from a string. Grind off a trifle from the heavy end.



Take compression reading and record it while the engine is new. Later take reading twice a season to check up on valves.



Carbide cutter cleans up valve seats in seconds. Unless valves are badly burned, light lapping will seat them. Otherwise, buy new

Don't neglect end-of-season lay-up



Grease and dirt make highly abrasive compound around spindles and drive shafts. In off season, wash and readjust for next year

After running carburetor dry with clean oil in crankcase, shoot oil through plug hole and pull engine over for winter protection.

belt life is often downright amazing. Weekly maintenance is something like a pilot's walk-around inspection before takeoff. Silly? Not at all, if

like a pilot's walk-around inspection before takeoff. Silly? Not at all, if just once it saves you from running without oil, wobbling off a wheel, cutting half the lawn with a loose blade, or conducting a flashlight search for a shucked-off clip or special part. Points to check before starting the weekly cutting chore:

Lube oil level.

 Wheel lugs or retainer clips or bolts.

 Dry, squeaky things that need a drop of oil.

Belt and idler tensions.

 Cutter-blade sharpness, setting, and security on the shaft.

Mid-season checkup. By mid-season, most mowers start to fight back a bit. Several acts are in order if you wish a continued happy relationship:

wish a continued happy relationship:

• Change the oil on mowers with four-cycle engines.

Clean the air cleaner thoroughly.
 Clean and re-gap, or replace, the spark plug.

Check engine compression.

 Snug down (gently) on head bolts, especially in exhaust-valve area.
 Clean the fuel strainer if one is

used on your particular engine.

• Pull wheels and clean and lubri-

cate axle bearings.

• Lubricate idlers, countershafts.

 Lubricate idlers, countershafts, and chain drives; readjust.

The need for cleaning, lubrication, and adjustment is probably self-evident by this time of year. The compression check may not seem quite so important. It is! For example, by mid-July, my mower has run eight to nine weekends. At about six hours per week, this is roughly 50 hours. In this length of time, the valves and head gasket can start to get into trouble. If I run another 50 hours with compression getting progressively worse, the rate of damage will shoot up quickly as the hot gases leak between valve and seat on every firing impulse. The same is true of a head gasket which has started to blow slightly. Continued running means a warped head.

Incidentally, among all causes of hard starting, my own experience has shown me that a leaking head gasket is just about the most common. A new one costs less than a dollar. Some engine builders recommend specific head-bolt torques. Check for your mower. Briggs says to pull down firmly with a wrench handle no more than 6° long. Thus, a ¾" socket will usually do just fine. It's worth repeating after the engine has warmed up.

In brief, if compression has dropped from a pre-season 110 pounds to 50 or 60, it's time for action. We'll talk

[Continued on page 116]



Now, a Do-It-Yourself UFO

By DAVID HEISERMAN

E arly in 1969, Dr. Edward Condon published results of a scientific study of unidentified flying objects. The Condon report cites atmospheric temperature inversion as one explanation for many UFO sightings.

Under normal atmospheric conditions, air at the earth is warmer than air at high altitudes. Light from the earth then passes through the temperature layers and into space.

Sometimes air near the earth is cooler than air at high altitudes. This temperature inversion occurs most often after sundown over desert areas or large bodies of water. If light from the earth strikes the inversion layer at the proper angle, the beam angles downward. An observer miles away can see it even though it may have originated over the horizon.

Suppose a car is climbing a hill. The headlights strike the inversion layer. An observer miles away may then believe he is seeing two moving spots of light in the night sky. A few degrees of car movement will sweep the reflected beams hundreds of yards across the sky. This can account for fantastic speeds associated with many UFO sightings.

Simulating reflection. You can, in a homemade refraction tank. Instead of a true temperature inversion layer, however, the tank uses the interface between water and air.

For the container, use a transparent box such as a small aquarium or a plastic shoebox. A small rectangular mirror, a magnifying glass, and a piece of thin plywood are other items needed.

To make a lens mounting, drill two off-center holes at right angles through a block of wood. One hole is for a ¹/₄" threaded aluminum rod, one for the magnifying glass handle.

After assembling the apparatus, put water into the container to a depth of about one-third the length of the container. To make the light beams visible, stir a few drops of milk into the water.

Place the apparatus under a strong light at least four feet above the magnifying glass. Use wingnuts to adjust the height of the lens mounting. Focus the light for the brightest ray through the clouded water.



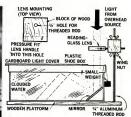
Headlights may spark UFO reports—as seen in sketch at top of page. Photo above is what you see in setup below.

Operating the tank. Pull the mirror up to 10 or 15 degrees from the container bottom. Observe the incoming beam of light and the beam reflected from the mirror. Raise the mirror angle slowly. When it reaches about 48 degrees the beam from the mirror no longer will pass through the surface of the water. Instead, it will reflect sharply off the surface and shine down to the bottom of the container. At any mirror angle greater than this critical angle, the light falls on the container bottom.

Build this setup and you can demonstrate why moving lights are sometimes seen in night sky



Photo and sketch show parts you need and how to put them together to show how

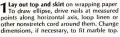


atmospheric temperature inversion can give rise to reports of unidentified flying objects.

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Building Fine Furniture: a Marble-Topped Table







2 Cut rough stock for apron at angles yieven. Check them on pattern. Alignment of leg positions is important, but angles are not critical if stock covers ellipses. Adjust angles, mark them directly on the wood.



3 Fasten cut-offs to outsides of apron members so you can apply clamp pressure. You'll need glue and toenails to take the pull. Check pieces on layout to make sure nails stop within areas to be cut off.



6 Tape apron layout on top of assembled segments and transfer ellipse. Dressmaker's tracing wheel does a good job, or you can use carbon paper. Arrange overlay to center splines between parallel ovals,



5 Use pipe clamps across each joint to apply even pressure. Glue up end and side segments. Cut 3½" wide leg spacers from ¼" scrap; insert them in spline slots to space segments 2" at each leg position. 110 POPULAR SCIENCE

By FRANK L. GREENWALD

B efore beginning construction of this table, you should make one important decision—whether you'll use marble, as I did, or settle for a substitute.

Your decision will depend partly on whether you can get the marble you want. You must have it on hand first, because its size and shape may require changes in the wood members.

For a color photo of how the table looks when finished, and for a construction drawing, see pages 72-73.

Apron. Begin by drawing the skirt pattern on the mahogany stock. Cutting angles can be marked directly on the wood, but check the cut pieces by actual layout. Since there is ample waste stock, the angles can be altered slightly for an accurate fit.

Using the pattern as a guide, locate a ¼"-wide and ¾"-deep spline slot in the end of each piece; the slot should be centered after the apron is cut from the rough stock.

The apron stock is first glued together to form two end and two side segments which can be joined by unglued spacers at the leg positions. Next, tape the pattern on top of the segments and transfer the outline of the two ellipses.

A bandsaw does the best job of cutting the ellipses. The inside cut should be made close to the line; leave about \(\frac{1}{16} \)" outside.

I tried several tools and finally settled on a rasp-type plane to shape and smooth the outside surface. Frequent checks with a square are needed to keep the surface flat. A 3" drum sander will remove any remaining irregularities. Then cut the molding grooves in the apron.

Legs, Start by cutting the four 2"square legs to 14½". Next, slot the tops to receive the apron splines. My slots were made with a dado head on a circular saw. It's easiest this way, and it is a simple matter to fit the splines to the curved bottoms of the slot. One word of caution—use a stop block on the saw table. If the cut textends beyond 2¾" it will show below the apron.

Each face of the leg is tapered $\frac{1}{2}$ " in $\frac{10}{2}$ ". When you use a taper jig on a circular saw, remember that after

Here's something no smoker should be without.



Put Tareyton's charcoal filter on your cigarette, and you'll have a better cigarette.

Tareyton's activated charcoal scrubs the smoke to smooth the taste the way no white filter can.







Ink in transferred lines with a fine fiber pen. All joints are now glued except at leg spacers. Before you disassemble segments, number leg positions to avoid mixup. Bandsaw and shape the glued pairs

8 Smooth outer faces of skirt, working from crown to end (or glued joint) and checking frequently with a square. When sawing, you should have left 1/16" outside line. The plane whisks off most of this.





9 Finish with a drum sander. Check with your fingers for slight irregularities, bumps and hollows. On inner surfaces you won't have risked much by sawing right to line; they won't need planing or sanding.

10 Spline slots are cut in two-by-two stock before legs are tapered. These were made with a dado head, so they curve at bottom. Splines must be shaped to match. Test leg (it before gluing in the splines



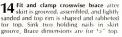
Web clamp makes quick work of final skirt and leg glue-up. Work on a level surface and use mallet to align members before tightening clamp. Note that legs and skirt are already grooved for inlay.

12 Make drill jig (see drawing detail) to position rim-holding screws. Check jig and stop on scrap. Each leg gets two 11/2"-#8 flatheads. Use 12 screws between rim and apron; drill for these after rim is set.





13 Use full-size pattern to arrange top-rim members. Notch waste at corners for clamp seats and adjust joint angles for tight fit before gluing and tracing oval pattern. Splines must fit the slots precisely. 112 POPULAR SCIENCE



two adjacent sides are cut the taper setting must be increased to 1" in 101/2" for the remaining two sides.

Top rim. Using a full-size pattern, cut and lay out the four pieces of rim stock. Adjust the angles at the joints as well as the splines for tight, dry fit,

After gluing the members, locate the pattern carefully on top, transfer the ellipses, cut out the rim, and mold it to the shape in the drawing. The inner lip dimensions are correct for a 1/2"-thick top of the size given in the drawing. If other materials are substituted, the 1/2" dimension may have to be changed. The actual marble top should be used as a template for the recess; allow 116" clearance all around.

Before any assembly work is started, sand all pieces thoroughly, first with =1/0 (80) and then with =3/0 (120) aluminum oxide cabinet paper. A reciprocating sander is best for all flat surfaces. If done by hand, use a flat block to obtain good leveling. All corners and edges should be softened (slightly rounded).

Assembly. Start with the four legs and apron pieces and make a trial fit, then disassemble, apply glue to all mating surfaces, and reclamp.

Next, place the rim on the apron and leg assembly and position until the overhang is even. The calculated rim overhang may vary somewhat, but this will not be noticeable after assembly.

After the best position is found, apply glue, clamp and screw up the assembly.

The drawing gives calculated dimensions of the cross brace, but it is wise to check the actual table. Apply glue to the brace, clamp in place, and fasten each side with two eight-penny finishing nails in the apron grooves.

The moldings. I made the roundedtop "16"-by-"16" apron inlay molding with a 1/1" bead cutter (Craftsman 9-2352) on a table saw.

Apply glue sparingly to two or three inches of groove at a time and clamp in the molding as you progress. Apply glue as needed until the molding reaches the next leg where it can be trimmed to length.

The end pieces will be more difficult due to the sharper curve. Notch the molding 132" deep every 1/8" on the

THE MATERIALS YOU NEED

Honduras mahogany to make:

4 pc. 2" x 3" x 15" and 4 pc. 2" x 3" x 12" (apron)

4 pc. 2" x 2" x 15" (legs)

4 pc. 14" x 6" x 26" (rim)

1 pc. ½" x 3½" x 24" (brace) 1 marble oval 18%" x 40%"

or substitute

1 sq. ft. bird's-eye-maple veneer 4 brass log sockets 1" square

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Your hands never leave the steering wheel. Because one foot pedal controls forward, reverse, and dynamic braking...automatically. We call it a hydrostatic transmission. You'll call it great.





15 Fit and glue the molding in the skirt groove. Do the sides first, starting at

a leg. Fit and trim at the next leg. If a piece backs of the end moldings every 1/8" so breaks, remove it, and start over, Notch they'll take the severe curve at that point.



Cut three overlong 1/4"-by-1/4" pieces 16 Cut three overlong /so joints are smooth and balanced. Glue front first, then match and glue sides. Sand off excess length of side pieces at rear.



17 Use a %"-wide block to position bird's-eye overlays uniformly above the leg beads. Same block can be used for all four overlays. Leave it in place to keep veneer from slipping as clamp tightens.



18 Brass leg sockets should be fitted in-dividually to level the table. Mark each socket for the leg it fits (arrow here shows outside). After wood is sanded and finished, attach sockets with 1/2" screws

back, and use slightly grooved softwood pressure pads under the clamps. Pull the molding into place slowly. If a piece breaks, remove the part already installed and start over.

Installation of the 1/4"-by-1/4" bead on the legs is a simple matter. I cut the front section to exact length and left the sides a trifle long. Glue the front in first and then fit the mitered sides. They can be sanded flush at the back after the glue has dried.

To glue the bird's-eve-maple overlays to the leg faces, use softwood pressure pads under the clamps, Apply glue sparingly; little is needed in this joint and all excess will have to be cleaned off.

A final light sanding with 3/0 (120) paper will clean up any rough edges and traces of glue. Use small wood blocks to sand in all corners, since any glue left on the surface will prevent stain from penetrating. Fit the brass leg sockets to each leg at this time, marking for later assembly.

To keep a natural finish on the bird's-eye maple, apply a coating of lacquer sanding sealer.

Inspect the whole piece for nicks, dents, or scratches. Small dents and scratches will usually respond to local steaming, done by placing two or three drops of water on the affected area followed by heat from the point of a soldering or a clothing iron. Complete the repair by sanding smooth. To reproduce the finish shown on my table, see the detailed instructions given on page 118.



Apply a good finish and you'll have a piece of furniture you'll always be proud of.

Any one of these will do the job









But only LEE fights acid-costs less, too!

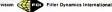
any one of these four top-rated oil filters will o a good job of cleaning your oil. But one of nem...and only one...fights the destructive cids that can build up in your engine. That ne filter is Lee. Only Lee has an acid-fighting eridium Anode to give you double protecon. Yet a Lee Oil Filter costs less than any f the other three!

ee filters are manufactured exclusively for en who take personal care of their cars, en who demand top quality and performnee. And don't mind saving money. They're bld in discount and auto supply stores. You an install a Lee filter yourself in a matter of linutes. That saves you time and money.



LEE FILTERS

For the man who takes personal care of his car



Keeping Your Mower on the Go

[Continued from page 108]

- about step-by-step procedure later. and blades. This is very important. End of the season. More mowers are · Sanding out rust spots and nicks.
 - · Spraying under decks, touch up areas or the whole mower.
 - Compression check and engine evaluation.
 - · Change oil.
 - Run engine out of gas with fresh oil in crankcase.
 - · Squirt clean oil into combustion chamber through the spark-plug hole. Cleanup may require two steps. Accumulated mud, organic crud, and cuttings yield best to a fat mixture of car-wash compound and a brush.

Flush off with a hose and let dry. This will have little effect on oil- and grease-loaded areas. Here, a solution of kerosene and one of the concentrated degreasers available at autosupply houses will do wonders. If you have a blast gun or choose to use an aerosol can, fog the dirty areas well and let it soak before hosing it off with water. Now, only the internal parts the degreaser couldn't reach will be dirty-the insides of reel-mower drive wheels, for example, or enclosed bearings and gear cases.

At this stage, temptation says "enough is enough" and if you have a complex assembly with special seals and lubricants, knowing when to stop is important. Generally, however, it's a good idea to get inside and clean away the muck and grit in favor of shining surfaces and new lubricant.

A valve job? Going back to the allimportant compression: If a late fall test shows you're losing the healthy squeeze on the combustion process so vital to easy starting and good power, now is the time to repair it. Even if vou don't do it vourself, vour dealer's shop will be in a better position to do the job over the winter.

A home valve job on a small engine shouldn't take long. The steps are listed in about the usual order:

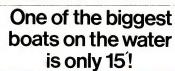
- Pull the cooling shroud and head bolts. Watch bolt length for position.
- · Loosen carburetor flange and pull carburetor aside. Remove keepers and push out
- valves
 - Wire-brush the valve clean. Clean seat area, piston crown,
 - Reseat valve and reassemble.

Part of the trick is to minimize the amount of disconnecting you do on carburetor and throttle linkage. Don't

move what you don't have to. If the valves look good, they can be refaced at any automotive shop for small change. If the valves are deeply grooved or burned, don't waste time and money. Buy new ones; they're inexpensive. Check the seats very carefully to be sure the inserts aren't loose. Try to turn them with a finger tip or knife point. If they are secure and fairly smooth, it may be that a simple lapping with a medium-grade lapping compound will seat them in.

A much better and more precise job can be done with a few light twists on a carbide-blade seat tool sold under the name of Neway by Neway Sales, Inc. of Corunna, Mich. A set of these beautiful little tools is a \$37 investment, but they fit all common aircooled engines, are factory-approved. and will last a lifetime.

Lap new or refaced valves to 116 POPULAR SCIENCE





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wrecked at the end of the year than

during the year. Snow comes and the

mower is pushed back behind the

snowmobile and the snow thrower.

Meanwhile, the accumulated corrosive

oil, cuttings, old gasoline, and dried-

out grease are pitting metal, locking

up ball and needle bearings, and plug-

ging carburetor jets. So, at the end of

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Comoro TX is big in buoyancy too. Molly Brown flotation foam (it's virtually unsinkable) adds 30 lbs. of buoyancy per pound of foam. Tri-hull design is smooth, Stable, And fast, Stern drive version handles 95 HP.

But there's one department that Comoro TX is not very big in. Price. Your dealer has the figures.

And we have a 20-page color catalog on our '70 Silverline fleet. For a free copy, write: Silverline, Inc., Moorhead, Minn. 56560. Dept. A-3.



Keeping Your Mower on the Go

[Continued]

cleaned-up seats very lightly. Look for a narrow, gray band of even contact all around. After reseating, grind a trifle off the valve-stem tips to get the right clearance with the lifters. Grind lightly and sneak up on the proper pinch on the feeler gauge.

It is a fact that small engines are expendable. After a few years, many owners find the engine almost impossible to start, low on power, and generally sick while the actual running and cutting gear of the expensive mower is still in good shape. If pulling the head shows valve-seat inserts loose and pounded into the block, the cylinder walls badly worn, and rocking the flywheel gives audible evidence of a loose piston pin and crankpin bearing, it's time for a new short block. It's a one-evening job.

Season start-up. A perfect winter storage procedure will, theoretically, produce a mower that starts on the first pull and is ready to run for the season. The likelihood, however, is that for one reason or another you will find vourself with a mower that's fairly new and in good shape except that it's been unused all winter. Moreover, you are faced with cutting the grass "right now" and just aren't about to get into a massive repair operation. Generally, the following technique will get the engine started, assuming a tank of fresh gas and a few husky pulls haven't gotten results:

 Pull the air cleaner, open throttle and choke, and spray a shot of ether starting fluid into the intake. Try a few quick pulls.

· If the ether doesn't fire, you have no spark. Remove plug and, with wire attached, crank the engine over with the plug resting on the cylinder head. Be sure the throttle is on "RUN". If you don't see a spark, try a new plug. If you still lack spark or the fire is weak and intermittent, don't waste time with more pulling.

 Remove air shroud and magneto, clean oil from point area, and run a fine point file between the contacts. Later, you can put in new points.

· Drop the flywheel back over the shaft and key, and spin it by hand. You should now get spark unless the high voltage is shorted or the primary grounded.

· Tighten up the flywheel and shroud and give another shot of ether. Nine out of ten times it will start.

The logic behind such procedures? If the engine doesn't fire because old

fuel has gummed the carburetor jets, a few power strokes from the ether will generate the air flow needed to flush them out. If there is no spark, you may have an oil or oxide coating on the breaker points, so you clean the contacts.

Is it time for a pro? If healthy ignition and starting fluid produce only brief sputters, the carburetor is probably gummed badly enough to require disassembly and cleaning. Commercial carburetor cleaner or lacquer thinner will do this job, but unless you are fairly handy with small carburetors and have the proper screwdrivers for jets, plus compressed air to blow them out, it might be well to borrow your neighbor's mower for today and let a pro do the job.

Unskilled disassembly of carburetor and governor linkage can produce a dandy mess to get back together. If you must, try making a sketch of the linkage details first, in spite of the fact that it may not look confusing before you take it apart.

A final point. Mowers are made to cut. Belts and pulleys can snick off a finger in a trice. Never tinker with a running mower! Pull the plug lead before touching moving parts.



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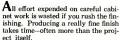
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How to Apply a Finish You'll Be Proud Of

Rubbing with double-0 steel wool and soapy water will give a satin sheen on furniture. For a higher polish, substitute triple-0 steel wool. Then use rubbing compound.



That was so with the marble-topped table described on preceding pages. The procedure I used can be followed for other projects, too.

In my opinion, nothing equals the brilliance, clarity, and permanence of water stains made from aniline dve. The only disadvantage: these raise the grain. This can be almost eliminated by a preliminary sponging with warm water, followed two hours later by a light sanding with 3/0 paper.

You may have a favorite finishing schedule for open-grained woods. For those who don't, here is a procedure I have worked out. It combines old cabinetmakers' techniques with the convenience of contemporary materials.

Staining. Mix up brown mahogany and walnut water stains in the proportion of 1 oz. powder to 1 at. boiling water. You can combine these in the following proportions to provide two different stains:

 One part brown mahogany, one part walnut, and two parts warm water. Label this mix 1/2 strength.

 One part brown mahogany, one part walnut, and six parts warm water. Label this mix 1/4 strength.

The mahogany is too red to suit my taste. The addition of the walnut produces a more subtle color. Apply the stain freely with a 11/2" or 2" brush, using the two mixes to even out the color in the different wood pieces. As the stain is applied, shake out your brush and go over the stained surface with long, smooth strokes. The stained wood, when dry, will not appear dark, but subsequent steps will change this. After allowing at least 12 hours for

the stain to dry, apply a wash coat of lacquer sanding sealer thinned one to three. After this has dried at least an hour, sand lightly to remove remaining traces of raised grain.

Filling. Since mahogany has open pores, filling is necessary. I used natural paste wood filler colored with walnut-pigmented wiping stain of the same make. This is applied according to manufacturer's instructions, using burlap to clean off surplus filler (wiping across the pores). Allow ample time for the filler to dry before any other coating is applied.

Inspect the surface carefully for remaining filler. Sand this away with 6/0 paper and wipe off, using a rag moistened with naphtha (benzine).

Undercoats. Lacquer sanding sealer provides good surface build with excellent sanding characteristics. I used three wet coats (sprayed) to reduce the chance of sanding through. Let the last undercoat dry four hours.

Sand the entire piece, using 6/0 garnet finishing paper. To avoid cutting through the undercoat: Dull the paper with one or two swipes against scrap wood, don't sand across any corners, and above all-sand lightly. Sand until all surfaces are dull.

Finish coats. Apply at least three full wet coats of clear gloss spraying lacquer to all surfaces, allowing each coat to dry about 30 min. Wait at least 12 hours for thorough drying. Rub to a soft sheen.

First wet-sand all surfaces with #400 waterproof paper and soapy water. Use a small rubber block to back up the paper (on all flat surfaces) and sand lightly until the surface is uniformly dull. Inspect frequently by wiping with a rag. Stop sanding while a few shiny spots can be seen.

Finally, rub with 00 steel wool, again using soapy water as a lubricant. Use even strokes, working with the grain until the surface has a uniform satin sheen. If you prefer a higher luster, use 000 steel wool and follow with suitable rubbing compound.-Frank L. Greenwald

118 POPULAR SCIENCE

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This is the dent that started it all, Estimates ranged from \$45 to \$55. Repair job starts

with sink plunger to redress cavity in door panel around the dent.

Roughing up, filling in, smoothing off



A drill with a disk sanding attachment will remove the paint and roughen up the metal surface so filler will adhere firmly. 122: POPULAR SCIENCE



Putty hardens quickly, so act fast. Don't be afraid of using too much—it can always be ground down. But apply it smoothly.

Beat the High Cost of Body Repairs

You can easily fix small dents with a few inexpensive tools

By JIM DAVIS PS West Coast Editor

It's happened again. Your car was safely parked, you thought—but when you came back, there was this deep scratch in the door. It isn't much damage, but your insurance policy has a \$100 deductible clause in it. Two body shops give you estimates of \$45 and \$55. That much money to fix a small scar? Well ...

But have you ever thought that you could fix it yourself? Dents, dings, wrinkles, scratches, and other small body damage can be fixed in a day, at home, with simple tools and inexpensive materials. If you start work on a Saturday morning, you could have the dents straightened and painted by about three that afternoon. If you think I'm kidding, read on.

You'll need a minimum of tools to produce a good job. The more tools you buy, the easier the job will become. I have done some fine-looking body bumping with a large rock and an old ballpeen hammer. But no doubt you'll want proper tools. This article isn't written to save you gobs of money on future body repairs, but instead will be useful to those of you who like to tackle something new and different on a day off.

Two tools are a must. You'll need a body hammer and a bumping dolly. How they can be used to shape sheet metal in various ways is shown in the drawing on page 126. A light bumping hammer is best for the beginner. It usually weighs less than 10 ounces, and has a head that is less than five inches long.

One good dolly is a toe dolly. It



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has enough edges, points, and curves to handle just about any contour on the car. The hammer and dolly can usually be purchased as a set from retail stores like Sears, Pep Boys, or Western Auto.

Next, you'll need some sort of power grinder. Perhaps you already have an electric drill. It can be fitted with a grinding attachment at low cost. A fexible rubber or plastic sanding block will also make things ensier for you. It will give you a better grip than just a folded piece of sandapaer.

Waterproof sandpaper. The amount of sandpaper you'll need depends on the size of the damage. Household grades of sandpaper, however, aren't much good for body work because these clog with paint particles so easily. Waterproof paper, sometimes called "wet and dry," is what you want. You can get it in all auto-paint stores and parts houses. Both sandpaper and abrasive disks come in many grades of roughness. The smaller the grade number, the rougher the paper. Grade 60 is quite coarse; 600 is very fine. The grade you want depends, of course, on the type of damage that you've got to work on.

Most dents, scrapes and wrinkles have a depressed area, with assorted paint damage around it. First job is to remove the dent, then make repairs on the paint. Every body man in the country has a pet theory on how to fix a dent, but all their theories boil down to the same basic facts.

The dolly does it. The dent was made with one hard blow, so straighten it out with one or two hard shots with a heavy, blunt piece. Use a lead hammer or even a smooth cloth-covered rock. When the metal is back to a semblance of its original shape, you can take over with the hammer and dolly. Hit solidly, but not so hard that you deform the metal. And get this: It's not the hammer that does the flattening. It's the weight of the dolly plus the muscles pushing it against the surface. The tapping with the hammer begins at the perimeter of the dent. As the spot begins to reform, you move slowly towards the center.

The drawings on page 126 show the different techniques used to straighten different types of damage. The basic idea in all these operations is to start at the ridges of the damaged area and unlock the strains in the

ridge, which will allow the sheet metal to return to its original shape.

Since most dents appear in the form of a cavity, most repair jobs start with working off the dolly. That means the dolly is used to brace one area of the metal while the hammer is applied to another spot. In most cases of both flat and crowned surfaces the hammer is moved around the perimeter of the cavity, while the dolly is kept in one place.

On convex surfaces the dolly is usually used as an anvil, which means you hammer on the dolly. The panel will be smoothed out between the working faces of the hammer and the dolly. For large waves or corners, this means moving both the hammer and dolly around until the surface has regained its original shape. For offsets or flanges in the sheet metal, the hammer and

mer hits at the edge of the dolly.
How hard do you hammer? Don't follow through as if driving nails. Keep your wrist loose and hit the metal in a series of glancing, slapping blows. How fast? Professional body men work at a rhythmic pace of about 120 blows per minute. You'll have to work slower though, until you learn just where to hold the dolly, and where to tap with the hammer. Incorrect placement of either dolly or hammer blows can add ripples rather than remove them.

You'll reach a point where continued hammering won't do any more good. At this stage, you're halfway home. Now you'll need some body filler and a squeegee. Polyester-base fillers have proved a lifesaver to body shops. They won't shrink or corrode, and they resist acids, alkalies, and gasoline.

Be careful about mixing the catalysts. Read the instructions on the can. After mixing, work fast; the hardening begins right away. Be sure that the surface is quite clean and free of old paint so the filler can bond properly with the metal.

Once it's hard, get out the rotary sander and grind the spot down flush with the surrounding surface. Don't try to get it perfectly smooth with the sander. Instead, use the sanding block and some medium sandpaper. Keep a trickle of water on the paper so the paint and plastic won't dog the grit. Run your hand over the surface to check for rough spots.

The only flaws left at this point should be air-bubble pits. That's where the body paste comes in. Paste dries very slowly, so apply thin coats at intervals, rather than one thick coat. Sand the whole spot with fine sandpaper and you're ready to paint.

Use aerosol paints. For this type of painting, you don't need an expensive compressor, spray gun, or other equip-

Masking, filling, wet sanding on primer



Mask the surrounding area to keep from praying undamaged parts. Keep the spray perpendicular to the surface at all times.



Primer coat should be thin. Fill bad spots and bubble holes with lacquer-base body paste in thin layers—it dries slowly.



Give surface a slow wet sanding before applying second primer coat. Use plenty of water to keep sandpaper from clogging.



Spray on the last coat of primer as evenly as you can. The text explains how to apply topcoats and finish off for a perfect job.

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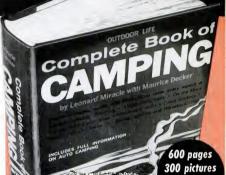
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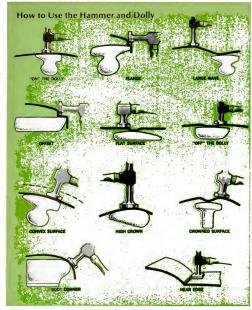
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ment. All you need are several cans of aerosol paints. Surprised? Lookif you take your time and think about what you're doing, you can paint a whole fender this way and make it look like a professional job. You need two types of paint-a primer and a finish color. Use a lacquer-base gray primer. But before you dash out with the paint, remember these simple rules. The spray must always his the surface squarely at all times. Swinging the can in an arc will cause buildup of paint in the center and a light, dusty coating at both ends. Read the instructions on the can for proper distance. Working too close will produce runs. Working too far away will allow partial air-drying of the particles before they reach the surface, which gives a pebbly effect. It's a good idea to practice on a piece of plastic or plyboow

If any bad spots show up when the primer is drying, fill them with body paste, and re-sand them when dry. Speed up drying with the heat lamp you keep in the house.

Aerosol paints to match your car

are available at any good auto paint store. Just give the man the make, model, and year, and show him the color. Specify lacquer—not one of the synthetic or acrylic enamels. I'll tell you why in just a moment.

At least three coats. Be sure that you shut off the valve at the end of each stroke to keep paint from building up. Keep your distance to assure a uniform finish. Put on at least three coats. Now the job is done-almost.

There is one part that can't be done the same day. Lacquer must be sanded and rubbed before it turns glossy -and the lacquer surface won't be hard and ready for that for three or four days. If you had used enamel, it would dry faster, but if you'd made any mistakes, there would be no way of correcting them. Lacquer is more forgiving. The final finish involves about 15 minutes wet sanding with ultra-fine 600 paper, using lots of water. When the surface feels like a sheet of glass, finish up with a rubbing compound. This will bring out the gloss and help to blend the repair in with the surrounding surface.

Gasoline and Octane Rating

[Continued from page 89]

ments for the very same make and model of new cars vary by several numbers. And, as engines age, the requirements may vary to an even greater extent, since each car owner drives his car differently and has his car serviced and maintained somewhat differently.

The results of one recent test provided striking evidence of the differences between individual car engines and their octane requirement. The Coordinating Research Council, a norpost organization jointly sponsored by the Society of Automotive Engineers and the American Petroleum Institute, in its 1968 study of octane requirements, measured the antiknock performance of 26 new, popular-make cars equipped with the same V-8 engine. These 26 cars varied in octane requirement from a low of 88 to a high of 96.

The results of this, and similar tests, led the Du Pont Petroleum Chemicals Division to conclude that, "It is clear from the variation in requirements among cars that neither the automotive nor the refining industry can predict in advance, nor advise the motorist, of the absolute octane level requirements of his particular car as he drives and maintains it."

MATCHING GASOLINE TO CAR

The inescapable conclusion to be drawn from any discussion of research octane ratings and their posting on service-station pumps is that the only sure way a motorist can match a gasoline to his car is to try different brands and grades, and to select the one or ones that perform best in his own car under his unique set of operating conditions. And, fortunately because knock is audible and can be heard by the motorist, his most reliable guide is his sense of hearing. With this warning, the consumer can quickly seek out and find a competitive gasoline that will perform well in his car.

Gasoline suppliers, too, know that the consumer can readily protect himself against an inferior product by changing brands if he is not satisfied with the performance of the gasoline he is using. The marketer who produced an inferior fuel would soon finch himself losing out to his many competitors. Competition among oil companies, even without posting of octan ratings, has always proved—and will continue to prove—to be the best as surance to the consumer of a constantly improving quality in moto fuel.

HOW TO MACHINE A

Boring-Bar Holder with Extra Talents

By WALTER E. BURTON

I wo pipe nipples and a cap are the major components of this sturdy boring-bar holder for a lathe. The attachment can handle tool bits too bulky for a regular tool holder.

Dimensions are for a holder to be clamped in the toolpost slot of a 9". South Bend lathe. The holder consists essentially of a length of pipe (or nipple) telescoped inside a larger, capped nipple. Two hold-down bolts evert pressure on the cap for gripping a boring bar extending horizontally.

Pipe fittings. You'll need a 2" nipple 4" long, a cap for this nipple, and a 1½" nipple 5" long. A plain piece of pipe could have been used instead of the 1½" nipple. You will also need two hexhead ½".20 bolts 4" long, one 6-32 bolt ½" long, and a ½".by-1½". by-2½" steel block machined to fit the lathe toolpost slot. In this, tap two holes 1½" apart to receive the ½".20 bolts.

Chuck the pipe sections, using a steady rest to restrain the outer ends, and machine unthreaded ends square. At the same time, trim the sections to approximate length. Final length of the 2" nipple is determined with the cap in place.

In the cap, drill six ½" (or slightly larger) bolt holes spaced uniformly around a 1½" circle. Screw the cap tightly on the 2" nipple, and machine the cap to reduce its bulk.

Boing-bar holes. Drill three sets of holes through the combined, telescoped pipe sections, at right angles to their axis, to accommodate boring bars. To do this, assemble the parts as follows: Cut a piece of 3/16" to ¼" metal or hardboard to fit inside the pipe cap so it will act as a temporary spacer between the inside of the cap and the end of the smaller pipe section. Make notches or holes to pass the two hold-down bolts.

Use wire rings, wedges, or other temporary devices to provide fairly uniform spacing between the inner and outer pipe sections when assembled. Near the bottom of the outer pipe, drill and tap through both pipe sections to receive a 6-32 bolt. Be sure that the inner section is tight against the spacer in the cap.

For accurate drilling. Using any pair of bolt holes in the cap, mount the holder firmly on the compound slide, and swing the slide so it parallels the lathe axis. Using the crossslide screw, center the holder (with respect to the nipple diameter) with the headstock-spindle axis. Start the hole with a center drill, use a small bit to drill pilot holes through all four pipe walls, and finally enlarge these holes to a size to take the boring bar. Move the hold-down bolts to another pair of holes and repeat the operation; then do this again. Thus, merely by shifting the holddown bolts to the proper holes in the cap, you can position the holder so any of three hole sizes will be used.

The precise hole sizes will depend on the diameters of the boring bars or other tools you expect to use.

Finishing up. After drilling the boring-bar holes, disassemble the holder, remove the temporary spacers and burrs and chips, and convert the 6-32 hole in the inner pipe section into a vertical slot extending down, from a point slightly above the original hole position, to the pipe end. The 6-32 bolt tip should slide easily in this slot.

When you reassemble the holder, tightening the hold-down bolts tends to move the outer pipe section downward, producing a powerful shearing action for gripping the boring bar. The total movement of the outer pipe will determine the minimum diameter of bar that any particular hole size can grip. You may find it desirable to convert one or more sets of round holes into square ones for gripping square or rectangular bars or bits.

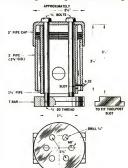


PROJECTS

Some of the versatility of the holder is seen in the photos above and below. Above, the holder, made of common pipe fittings, is used to machine inside a brass sleeve.



Tool bits that wouldn't fit common holder go into this one. A rectangular-section, high-speed steel bit is being set up for chamtering inner edge of a cast-iron ring.









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SHOP TALK

By ROBERT P. STEVENSON

Wood butchers, beware! Tool-wielding women advancing

I'm still not sure how all of us masculine wood butchers should react to a news report out of Los Angeles which says that more than 40 percent of all hammers, screwdrivers, and handsaws sold annually in the U.S. for home use are being bought by women. Say that again? Yep, 40 percent-and the percentage is growing every year. This trend was revealed in a nationwide study conducted by Pendleton Tool Industries, Inc. According to the survey, the largest single group of women buying tools is in the 21 to 35 age bracket. That figures, I guess, since 21-35 is probably the most active period for fixing up the home nest. Will the trend lead to the sale of "his" and "her" tools? Well, perhaps not; but Frank McDermott, president of Pendleton, has this to say: "We've changed the design and finish on several of our lines of tools to make them more suitable for a woman's hand." So now you know.

Red cedar shingles come in a variety of fancy butts

So maybe you think of a wood shingle as always having a square hutt? Not so. Take a look at the range of fancy-butt shingles I saw on a recent visit to headquarters of the Red Cedar Shingle & Handsplit Shake Bureau, Seattle, Wash. Their names: 1. diagonal; 2. half cover; 3. diamond; 4. round; 5. hexagonal; 6. octagonal; 7. acorn; 8. arrow; 9. fish-scale. Those aren't all the possible styles, either. The bureau notes that since fancy-butt shingles are custom-produced, "the variation in shapes is limited only by one's imagination." Fancy-butt shingles are always 5" wide and either 16" or 18" long. Laid with a weather exposure of 6", a square of the shingles will cover an area of 100 square feet.

Specialty products often may have other uses

Products designed for a special function often can be made to fill other needs if you only know they exist. That occurred to me on a recent visit to the Simpson Timber Company in Seattle, Wash. The products that prompted the thought: Simpson Skidguard and Simpson Thermolam Insulated Ice Floor. Skidguard is exterior-type plywood with a plastic overlay into which a waffle pattern is embossed. The surface provides safety wherever moisture might make slippage a problem-on boat decks, docks, house decks, poolside patios, and other walkways. Thermolam consists of a sandwich of \(\frac{1}{2}''\) polyethylene insulation bonded between two face panels of \(\frac{3}{8}''\) overlaid plywood. The 4'-by-8' panels make it possible to turn an ice arena into an auditorium (or back again) in less than two hours. The sandwich layer protects the ice from melting when the hall is heated. What other uses could you find for these products?

Current free pamphlets include one on tool sharpening

What sharpening stone should you use for each sharpening job and how should you use it? A new brochure gives good-to-know facts about sharpening knives, plane blades, chisels, mower blades, home cutlery, hatchets, axes, and other tools. Write to F. T. Capalino Jr., the Carborundum Co., Box 477, Niagara Falls, N.Y. 14302 . . . Masonite offers a full-color brochure showing many beautiful things you can do with Royaltile panels in a bathroom. Send a postcard for Form 7024, Masonite Corp., Box B, Chicago, Ill. 60690 . . . For a booklet describing the use of particleboard, hardboard, and plywood underlayments for floors, write R. E. Perdew, Georgia-Pacific, Box 311, Portland, Ore. 97207.

Special firearm commemorates Texas anniversary



Even if you're not a gun buff you'd take a second look at the handsome hardware in this photo. A star-studded border surrounds a large star, and the dates 1845 and 1970 adorn the gold-plated receiver on a lever-action firearm that Winchester offers this year to commemorate the 125th anniversary of the Lone Star state.

128 POPULAR SCIENCE

Toothless Sawblades

[Cont. from page 101]

Which grit? All grits cut comparatively smooth edges with little feathering and chipping. Fine-grit tungsten blades should be used in thin, hard materials when cut quality is important, most particularly when chipping or delamination might be a problem. Medium-grit blades can be used if you wish the job to go faster, or if you find that the material you're cutting is packing between the tungsten-carbide particles.

Coarse-grit blades cut the fastest, and since they form a wider kerf will make smaller radius cuts than blades with finer grits. This is akin to being able to make a tighter turn with a wide, heavy-set blade than a no-set, narrow blade. There's just more room to ma-

neuver. Tool speed can be a

factor in working most efficiently with toothless blades. On a saber saw, slower speeds work best on such materials as stainless steel counter-top materials. I found it best, in all cases, to start at a slow speed and, when necessary, rev up slowly to a speed that would keep the blade cutting most efficiently.

The bandsaw blade. The speed factor is even more important on a band-saw. If you planned on cutting all

materials from tool steel through ceramics to wood, you would require speeds (in fpm) of 150 to 3,000, and in some cases you would even require a coolant. However, for average homeworkshop chores involving common materials, the normal range of woodworking speeds is fine.

The blade was impressive on a whole range of materials I tried. With care, it made near-perfect cuts in unsupported aluminum - you hold the material flat around the blade area



compact, portable power shop.

The Moto Shop weighs only 12 pounds. It operates on a table top and stores on a shelf. It is basically a jigsaw with a 15-inch throat. It has a power takeoff for a grinding wheel, sanding disc, or buffing wheel. And there's a flexible shaft attachment, too, for carving, polishing, drilling, etc.

When an idea takes shape, Dremel Moto Shop shapes the idea, Build a better dream, Dream priced at \$37.95 to \$54.95.



Dremel Moto Tool—the most versatile tool you can own . . . grinds, carves, own . . . grinds, carves drills, polishes, deburrs arnis, polishes, geburrs, sharpens, engraves, routs! Fastest, most powerful tool of its kind. Permanent mag-net, 30,000 RPM constant torque motor defies stall-ing. Complete kits with storage case and 34 accessories from \$34.95 to \$49.95.

Creative Power Tools

Years from now, you'll be glad you got a Dremel creative power tool today. Not just because its superior quality makes it outlast and outperform them all . . but also because years from now your grown-up children will be closer to you, cherishing the memories of when your family had the fun of Building A Better Dream together.

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WRITE for free literature or see your dealer for a demonstration. Send \$1.45 for 160-page "Oremel Handbook o Hobbies, Crafts and Projects." It's jam-packed with funfilled projects for the whole family.

DREMEL

CREATIVE POWER TOOLS Dremel Mfg. Co.

and feed just enough to keep cutting. The bandsaw blade cut plastics at

regular woodworking speeds without the fusing of waste that can occur when working with a toothed blade. Edges require little work to bring them to a bright polish.

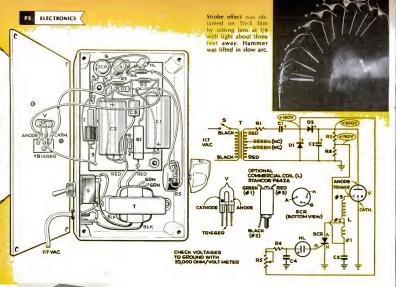
I tried it, too, on a section of solidcore door. The medium-grit blade works with a very fine kerf and causes as little feathering below as it does

The Remington toothless saber-saw

blades should be available in local stores now. Bandsaw blades are something else, even though they are being used widely in industry. Best bet here is to check price and availability by contacting the Remington Arms Co., Inc., Barnum Ave., Bridgeport, Conn.

There is a possibility that a tungsten-carbide-grit circular-saw blade may be coming up, and I'm on the list for one. I'm looking forward to receiving it and telling you about it.

MAY 1970 | 129





When mounting reflector around bulb, adjust to avoid hot spot. Unit is small enough to tote to parties, plugs in any 110 outlet.

Variable-Rate Repeating Strobe Light You Can Build BY STEPHEN DANIELS

Rapid bursts of light add interest to photos, give party action the flickering look of old-time movies

Strobe flash effects are everywhere these days—in theatres, go-go clubs, advertising displays. The stopped-motion flicker is eye-catching, and it can add punch to a private party, as well. Once you own a flasher, you can also have fun experimenting with multi-image photos.

High price tags on commercial units have been the hitch to owning one. But thanks to the availability of a low-cost flash tube and SCR, you can build this electronic multiflash for less than the price of a cheap speed-light. All parts for the version 130 | POPULAR SCIENCE

shown here ran slightly over \$17. Easy assembly. The unit shown is built into a 2"-by-3¾", by-6¼" phe-nolic instrument case. Most of the components are wired on a 3"-by-4" piece of perforated phenolic. To start, locate and drill holes in the case for the line cord and line-cord-terminal strip (S, T, and RI above); mount the strip, the cord, the switch, and the transformer. You can now wire the power circuit. Start on the circuit board proper by locating and drilling two holes, which allow the board to slip down onto a pair of metal spacers.

Use the board as a template to make these holes in the box. As much of the wiring as possible should be done on the top of the board, but a few leads must run underneath. Leave terminations for the input from T, L, R5 and both ends of D2.

Wiring the flash tube. Cut a ¾/c"-by1" slot in the top of the box to pass
the contacts of the flash tube. My FT106 tube came from Bowman Electronics, 155 E. First Ave., Roselle,
N.J. and cost \$3. Secure the leads to
a terminal strip mounted as nearly
flush as you can possibly mount it

Build a Strobe Light

[Continued]

the bottom of the case. A piece of okup wire insulated with coil dope ould be connected to the high-voltterminal of the tube. Make contions from board to tube and unt the board in the case on its ndoffs. Connect T. mount R5, and e the control into the circuit.

rigger coil-make or buy? A comrcial trigger coil can be used for L, I had accurate results with a ne-wound unit. To make it, start h a piece of "ps" plastic or fiber tub-. Bore two holes about 516" apart I thread one end of No. 22 enamd wire through. Wind ten close ns. Dope carefully and wind a sinlayer of cloth or plastic tape over turns. For the secondary, use No. or No. 40 enameled wire. Wind 70 amble-wound turns in the same dition as the first winding, dope and dry. Repeat this procedure three re times and dope the final layer vily. Connect the end of the priry to the start of the secondary to e an auto-transformer configura-1. The junction of the windings ms terminal 2. I glued the coil in ce to keep it away from other parts the circuit. Terminal 3 should be ated as shown.

leady for testing. Turn the unit on. should immediately begin flash-. Top limit is set by R4. This reor may be lowered somewhat, but longed operation at very high eds will shorten the life of V. o voltmeter checks are indicated the diagram, to help you track vn anv problems.

hotos may be taken with the cainaimed into a dark room, the subagainst a dark background. With strobe two to four feet away and ight angles to the subject, you can film as slow as ASA 125 at aperes of f/2 to f/4. You can also use unit as an auto-timing light.

One word of caution: Most people uncomfortable watching strobe its in dark areas, and some (epitics, for instance) should never k at them. So turn the light away n people, and use it with care. The comfort is lessened, of course, if the m is not darkened-but then so is strobe effect.

PARTS LIST

-RCA 2N3529 02-400 PIV silicon diodes fura FT-106 tancor P6426 (or see text) NE-2 20-ohm, 5 watt 68K 120K 1 meg 10 meg linear potentiometer

C1-12 mfd, 450v C2-20 mfd, 450v C3-.05 mfd, 400v C4-.1 mfd, 400v ransformer S-SPST toggle

Misc: case, perf-board, terminals, line cord, knob, reflector (from BC flashgun or equiv.), hardware



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Dect. 450. For River Grove, Illinois c002 MAY 1970 | 131

The Case for Central Air Conditioning

[Continued from page 69]

 A fairly new, modern, warm-air setup usually requires no more than the addition of a fan-cool unit. The original furnace fan moves the cold air as it moves warm. The fan in the fan-cool unit takes care of the extra air-moving load caused by the cooling coils, air filter, etc.

A new do-it-yourself kit lets you add central air conditioning to your present forced-air heating system for about \$450; it involves less than a day's work with ordinary shop tools. (For information, write Albion Div., McGraw-Edison, 714E No. Clark St., Albion, Mich., 49224.)

- Older warm-air systems may not have the air-moving capacity, since cold, heavy air is harder to push around than warm, light air. In this case, the fairly simple solution is replacement of the old fan with a larger one.
- In an old house heated with a gravity air system, or perhaps updated from gravity to a version of forced air by introduction of a blower, the problem becomes greater—and so variable that generalities are risky. You'll get your best answer from a local air-conditioning contractor. However, in a great many cases, it is

possible to hook a cooling coil into the system in a way that will produce satisfactory cooling. It's not so simple to achieve the side benefits of air cleaning and humidification, however, unless you junk the old furnace and replace it with modern warm-cool equipment. That is, in fact, the recommendation of most air-conditioning authorities, who point out that a modern all-function unit is so efficient that it will do its job even when hampered by less-than-excellent ductwork. And it will do its heating work so much better than the old system that the new one pays for itself.

- If your house is an old two-story building, it might be best to add cooling to the furnace and let it handle the first floor. Then, install a small unit in the attic to cool the upstairs.
- In a hot-water-heated home—the "hydronic" system—the problem is still tougher. You can replace simple hydronic radiators with recently developed units, which include small fans and rather more elaborate fins to transfer heat. In hot weather, chilled water runs through these radiators. The authorities say that the cooling is excellent, but the cost is high, compared to air systems. In

addition, you do not get the benefits of cleaned air, nor of whole-house continuous air circulation.

When the decision in a hydronicheated house is to install a central system, ducts go in through basement or crawl space or attic. For a twostory house, you use basement ductwork to handle the first floor and attic duckwork to handle the second. The ducts are often easy to tuck into comers and along ceiling edges.

Serious thought should be given to replacement of a hydronic system with an entirely new CAC central system, particularly if you're operating an old furnace with old-fashioned radiators. You'll save space, and much of the cost of a new installation will be relieved by the efficiency of a modern system, plus the reduced upkeep and maintenance charges of one system vs. two.

How about window units? A roomsize conditioner—or even a team of them—can never produce the overall performance you get from a central system. If a unit is installed in a confinable room, it will do a pretty fair job for that room. But if the room connects with another—if the door is left open, or if there is considerable

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For information on how to use smokeless tobaccos, please write: United States Tobacco Company, Dept.PS, 630 Fifth Ave., New York, N.Y. 10020. Skoal' and Copenhagen'

The Case for Central Air Conditioning

[Continued]

in-and-out or through traffic-the effect of the air conditioner is diluted.

In most houses with interconnecting living room, dining room, kitchen, family room-and hallways-the only confinable rooms are bedrooms. Thus, a room conditioner can do a good job in one bedroom. Two of them handle two bedrooms. It takes three for three.

And-at about the level of three room-size conditioners, your investment starts to reach the cost of a central system. This is particularly true if you resort to an outsize model, hoping to take care of a combination living-dining situation.

Room units are becoming more sophisticated. They now have models that sense temperature needs and modulate to produce the comfort level desired. Some models even have a reversal phase. When it gets too cool, they turn on the heat and move warm air into the room. Some have two or three levels of output, and you can

set them to meet changing conditions. But they continue to be, at the best, cooling systems that serve mainly to make sleeping rooms comfortable dur-

ing intolerable weather. Central equipment is likely to have a basic engineering advantage over a

window air conditioner; the two systems evolved from different sources. Window units have traveled the home-appliance route, and their projected life is about seven years. Central home equipment, on the other hand, is an outgrowth of industrial installations - sophisticated systems designed for office buildings. The projected life of such equipment is at least 20 years.

Can you pre-guess costs? Not very accurately. Too much depends on the orientation of the house, the size and position of its windows, even the color of its roof (a light roof reflects heat, while a dark one can add as much as 20 percent to the heat load). Insulation is even more of a factor in cooling than it is in heating, for the simple reason that vast excesses of heat can be produced when the heat loss is high, but it is impossible to produce enough cold, cleaned, and dehumidified air to offset excess "cold loss."

The industry does have some rules of thumb on costs:

- A house that is well designed. well built, and well insulated will require roughly 12,000 BTU for every 600 square feet of floor space.
 - In new construction you'll pay

somewhere around \$225 to \$250 for each 12,000 BTU of cooling.

· In an existing house the cost is a little more than new constructionabout \$250 to \$375 per 12,000 BTU.

For further information on central air-conditioning systems, write one of the leading manufacturers listed below-or ask a local heat contractor.

Airtemp Div., Chrysler Corp., 1600 Webster 5t., Dayton, Ohio 45404.

American Standard, Inc., Residential Air Conditioning Dept., Woodford Ave., Elyria, Ohio 44035. Bryant Air Conditioning Co., 7310 W. Morris

St., Indianapolis, Ind. 46231. Carrier Air Conditioning Co., Carrier Pkwy.,

Syracuse, N. Y. 13201. Climatrol Industries, Inc., Ste. 1810, 633 W. Wisconsin Ave., Milwaukee, Wis. 53203. Fedders Corp., Edison, N. J. 08817.

General Electric Air Conditioning, Appliance

Park, Louisville, Ky. 40225. Heil-Quaker Corp., 647 Thompson Lane,

Nashville, Tenn. 37204. Lennox Industries, Inc., 200 5o. 12th Ave.,

Marshalltown, Iowa 50158. The Trane Co., 206 Cameron Ave., La Crosse, Wis. 54601. Westinghouse Air-conditioning Division,

P.O. Box 510, Staunton, Va. 24401. Whirlpool Corp., Benton Harbor, Mich. 49022.

The Williamson Co., 3500 Madison Rd, Cincinnali, Ohio 45209. York Division, Borg-Warner Corp., P.O. Box

1592, York, Pa. 17405.

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Seagram Distillers Co., N.Y.C. Blended Whiskey. 86 Proof. 65% Grain Neutral Spirits. MAY 1970 | 133

Four-Track Crawler with Hoverpads

[Continued from page 59]

straight lengthwise while the tractor itself moved at an intermediate angle.

With four tracks driven, the resultant speed and direction is the vector sum of the speeds of the individual tracks. Thus the crawler can turn sharp corners, zigzag, orbit in a circle. or trace a spiral—all while facing the same way. It moves like a coin slid by your finger around a tableton.

This peculiar locomotion would be ideal for a forklift truck working in the narrow aisles of a warehouse; for remote handling of radioactive, explosive, or other dangerous materials, or of anything in hazardous areas.

Combined with hoverpads to float the load on air cushions, these tractors could shift heavy machinery with pinpoint precision, or even maneuver giant aircraft in a hangar or on the tarmac.

Like Topsy—it grew. The idea was originally developed by Dr. Doxey as a small vehicle to carry a flame cutter over heavy steel plate while running on the smooth surface.

The tractor has an inverted steel box for a chassis, and is two feet square overall. Tracks are made from motorcycle-type roller chains, and each link is flanged at the sides to carry a transverse U-section channel with two nylon rollers.

There is spring suspension for the bottom stretch of each track to ensure that all four bear firmly against the running surface. Tensioners take up slack in the chains to eliminate backlash for precise movements.

Drive motors and associated circuitry are inside the box. A separate five-watt AC two-phase servomotor drives each pair of tracks. Drive is through 1,000-to-one reduction gearing and a solid shaft. No differential is needed.

The direction of travel is controlled by a cunning device called a "synchro resolver." This is essentially a voltage divider with individual outputs for the two motors. Both outputs are simultaneously variable from zero to maximum, but the vector sum of the two voltages is always constant.

Thus, when both motors are fed with the same voltage (and therefore run at the same speed), you get 45-degrate travel. Lower one voltage and raise the other, and the angle of movement changes. When you stop one motor the other gets full power, and the tractor travels straight ahead or sideways. But whatever the direction.

the linear speed is constant when the input voltage is fixed.

input voltage is fixed.

Something like a radio compass or direction finder, the aiming device is basically an iron-core transformer with a rotary primary coil centered between two secondary windings positioned like the legs of a right angle. When the primary exactly bisects this angle, both secondaries have exactly equal voltage. Move it a bit and one output winding gets more voltage, the other less.

Turn the primary parallel to one secondary and that winding takes the full voltage. Rotate it 180 degrees, and the voltage remains the same but the motor reverses (these servo units can run backward).

The synchro resolver can handle only very low power; the input is a couple of volts at a few milliamps. The output from each secondary is boosted to 20 volts at a quarter amp by solid-state amplifiers housed in the tractor chassis.

"Driving" the machine. I had a crack at it, and the response is uncanny. You just point the arrow on the single control knob in the direction desired and the tractor scoots off that way. Set the arrow to "north"



NAUTA-Line 28'-The Biggest 28 Foot Boat Afloat!

If you've always wanted the fun, comfort, convenience and excitament of HouseBoating ... Natla-line's new 28' model is for you. HouseBoat comfort, convenience and living space with Yacht styling and performance. .at a third the cost of a similar hull length boat. Natla-line's exclusive interior design lets the direct side away quickly and easily.

It opens the interior up to the largest, brightest living and fun room of any boat in its size. It has all the space, comfort, and conveniences of many 35' cruisers. . .

It sleeps six full grown adults in comfort. Designed for women, the spacious and complete kitchen and bathroom are located aft for more living room. Fantastic storage areas extend your cruising time and fun. There's storage under everything! There's even a storage room under the pilot house for big bulky storage.

Interiors are sleek and loaded with luxury. Easyclean vinyls, bright work inside, and all fiberglass exterior reduces maintenance and work to a minimum.

We've retained Nauta-Line's classic lines that have made her the most copied boat afloat. Because safety is important, Nauta-Line adheres to or exceeds NFPA, YSB, BIA, and U. S. Coast Guard recommendations.

Safety glass is used throughout, not just in the windshield as in some competitive models. Should you give your family less?

And Nauta-Line's exclusive "Foremost Protection Plan" gives you "Full Insurance Coverage" anywhere in the Continental United States. Compare styling and performance. Compare convenience. Juxury, quality construction and

compare syming and perioninance. Compare convenience, luxury, quality construction and most of all, living space. See it., Deleve it., you'll agree that Nauta-Lines More than a House-Boat... More than a Yacht... a Breed apart. New 28' Nauta-Line for 70... \$,9395. New 34' Nauta-Line for 70... \$11,995. New 43' Nauta-Line for 70... \$21,495.



Four-Track Crawler with Hoverpads

[Continued]

and the little machine glides straight ahead; to northeast, and it veers off to the right on a 45-degree course; to south, and it instantly reverses. I spun the knob slowly with my fingertip and moved in a tight circle.

Linear speed can be altered with a second control. This is a rhoostat that varies the input voltage, and gives you a range from a barely perceptible 1½ inches per minute to a stately creep of three feet per minute, the maximum rate for a flame cutter.

But speeds of the individual tracks could also be varied independently to give even greater flexibility of movement, such as rotating around a fixed point, following a curved path, or making sharp angular turns without radiusing the corners. That is what's happening up near Newcastle-on-Tyne, where A. Reyrolle & Co. are preparing to use these tractors to shift around ultra-high-voltage equipment.

Giant structures, such as the 400kilovolt circuit-breakers for the national grid, are type-tested in the company's vast lab, which is of aircraft-hangar proportions. Here, everything must be mobile. These great towers must be inched up against a wall, girder, or transformer to establish the exact distance at which flashover occurs and clearance is safe.

Moreover, this monster equipment must be remotely positioned from outside the screened-in and locked enclosure, for no one is allowed inside when the lethal sparks are flying.

Enter the remarkable tractors. But this electrical equipment is hefty stuff, more than these tractors could drag even on wheels. So Reyrolle plans to mount it on hoverpallets to support the weight, while the little crawlers nudge it around the floor. Les Fisher, one of the factory engineers, showed me a seven-ton pallet he had designed for a transformer.

Measuring eight by 10 feet, it has a simple steel-girder frame carried by eight hoverpads. These are three-foot-diameter plywood disks with segmented skirts to enclose the air cushions, giving a hover height of 3½ inches to clear cables on the floor.

Air from a separate 25-hp motoblower delivering 1,300 cubic feet a minute is ducted through four-inch flexible hose to plastic soil pipe of the same size that rings the platform. From there it is piped to the individual pads, which operate at the low pressure of two psi. These pallets will be maneuvered by four separate tracks linked by jointed suspension arms to each side of the platform. This arrangement allows the tracks to climb freely over cables without tilting the load.

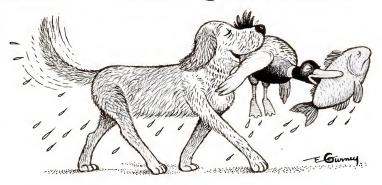
Tracks are two feet long and 3½ inches wide, and have 1½-inch rubber rollers like those on skates. Each assembly is self-propelled by a built-in half-horse motor with reduction gearing and belt drive to allow slip when the track encounters something higher than it can surmount. Speed will be limited to about a foot per minute.

Reyrolle is the first large-scale industrial user of the omnidirectional tractor. The crossbreeding with unique pallets of its own design is a real breakthrough in gentle handling and precise shifting of massive weights. The idea seems a winner. The combination could be a real

money- and space-saver in moving jumbo jets at congested airports. With the plane's wheels rolled onto low-slung hover pallets and agilely jockeyed about inside the hangar and over the apron, the system would literally run rings around the conventional—and awkward—tractor and towbar method.



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Boost for Turbocharged Cars

[Continued from page 50]

was long intake tracts that led to both cold- and hot-starting problems." The May principle means putting a normal carburetor under pressure. To this end, the air cleaner can is welded tight and works as a chamber for compressed air. A bypass valve holds pressure below 9.3 psi.

"General Motors must have spent more on turbocharging than on any single auto system in history, but they started down the wrong path," says May, "I believe they were wrong to operate from 2,000 rpm upwards. That produced a hole in the torque curve high in the rev range and overloaded bearings and crankshaft."

Finally, in May's book, they erred in controlling turbocharging variables by regulation units on both hot and cold sides of their engine.

May fits two control units: Both are on the carburetor. Running his entire system from the cold side only is May's original bright idea. "And it was cheaper, because we combine control of surge limits, engine loading for anti-knock values, and performance limits via fuel/air regulation within one mode.

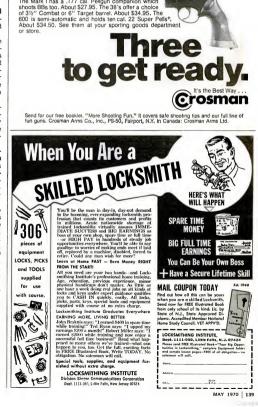
The Turbo May Capri engine delivers 180 hp at 5,750 rpm with a distributor cutout at 6,200. The chunky V6 could be made to give even more power: May has raced a 250-hp version with stock block.

What does the blower do to performance? A standard Capri manages just over 100 mph and will do 0-60 in about 12 seconds. A Turbo May Caori does 0-60 in just over eight seconds! How about flexibility? The engine is so tractable it will pull away rom 15 mph in top gear!

The May turbocharger doesn't go to work unless engine speed exceeds 3,000 rpm. Unblown torque of some 135 lb.-ft. peaks at 3,000 and trails off, in the way of suction engines. At that point the turbocharger takes over, reaching nearly 180 lb.-ft, at the 6,200 limit. And its curve is still climbing.

For a given steady speed the turbocharged car consumes 12-15 percent less fuel, because its engine is loafing. This gain is offset by increased consumption on wide-open throttle aceleration. That seems a small price o pay for such a tremendous gain in performance. May claims fuel consumption parity with the standard Capri engine under European condiions, with speed-limit-free highways. In America, the Turbo May Capri night even give better fuel economy, especially when used on long trips. Merely for local driving in the congested cities, of course, it would not be worthwhile.







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Miracle Cures for Boats

[Continued from page 102]

sand down to bare wood. When you apply the epoxy, it combines with whatever oil remains and then hardens. Hysol EA 913 is one such product. It costs about \$13 a quart.

Hardening rotted wood. A soak-in resin will restore the delaminated plywood door and cure rot in the keel. In general, you can figure that an ounce of Calignum or similar permeating epoxy will restore about three cubic inches of rotted wood.

You flow the resin into the open edge of the plywood, between plies. Or if the plywood is delaminated in the middle, you drill holes or slit the top ply to reach the inside.

To harden a rotted keel or strake you hand-drill 3/8-inch holes 31/6 inches apart to the depth of the rot. If the rot is wet, you'll have to dry it first. Acetone speeds evaporation; just be sure to keep flame away and ventilate thoroughly. Keep pouring resin into the drilled holes until they stay full-it will saturate the rot and harden to a greater toughness than healthy wood.

Another quickie repair, once impossible, is sealing tiny leaks in the foredeck and cabin roof. A thick-coat epoxy, like Fibreglass-Evercoat's twopart Seal-It, will close fine cracks and pinholes up to 10 mils wide (a sparkplug gap is about 25 mils). It hardens overnight to a flexible covering and cures to full strength in three days.

Caulking the hull. Sealing yards and yards of gaping seams is the biggest job of all. But when you've finished, the rubbery bond between planks will last many years. A neoprene-based synthetic fills seams up to 3/8-inch wide and stretches or contracts with the planking.

It's best to match a caulk with a similar coating to form a completely watertight system. One team, for example, consists of Sav-Cote poly-sulfide caulking and surface coating. Another is Seaprene's hypalon caulk with their neoprene surface coat.

Below the waterline, you can caulk seams with the new micro-crystalline wax and hydrous magnesium silicate fiber caulking. Called Slick Seam. it seals wide seams easily, sticks to wet as well as dry surfaces, and never becomes brittle. You can even apply it underwater, but not above the waterline; summer sun makes it soft. Restoring weathered fabric. Among

the easiest rejuvenating jobs now are seat cushions, vinyl-covered cabin tops, battered docking fenders, and canvas awnings. You brush on flexible vinyl coatings, like Recoatit; let dry, they look and feel just like new vinyl fabric.

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Miracle Cures for Boats

[Continued]

When the fabric is torn-like that ripped awning-you can fix it quickly in place without sewing. Brush on a multi-resin flexible adhesive like Patchstix. Then bond the patch with a hot iron: it becomes rubbery and waterproof, won't soften in the sun.

Cleaning rusty machinery. When the engine's locked up by rust, as on the cruiser you looked at, free up the moving parts first with penetrating oil. Then separate the rusted parts and apply a remover like MDR's liguid Rust Away, or Woodhill's Naval Jelly. After the remover's had a chance to work, wash it off.

Finishing-up work. For sealing around windshields and port lights, you can buy caulking-gun cartridges of polyurethane or silicone rubber. The polyurethane must be painted over for protection from sunlight. Silicone sheds paint and doesn't need it.

fill with a polyester putty like Fiberglass-Evercoat's Formula 27-it hardens for sanding and painting in 20 minutes. Or you can use an epoxy mender that hardens in five minutes under a heat lamp (four to six hours at 70 degrees).

Brightwork comes clean with shine-

up preparations like MDR's ABC Metal Cleanser, which works in 30 to 60 seconds. You can even "mothball" a boat's chrome, aluminum, and brass with Peel Away, a brush-on vinyl.

If these amazing new chemical cures had been around a decade ago. you'd see many more wooden boats afloat today. They can't reverse the swing to other boat-building materials, but they have created some terrific bargains.

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SKAMP Patrols Ocean Beat

[Continued from page 70]

manned sea stations and moored buoys, SKAMP would cut the need for the operation of seagoing maintenance ships.

What happens during hurricanes? Or long periods of "no wind" conditions? Schleiben explains that SKAMP could be driven off station by high winds or ocean currents, but as soon as the weather assumed a more normal pattern, the craft would automatically return to its position. SKAMP has already been tested in winds of up to 40 knots. Research also shows that "windless" conditions lasting more than three or four hours are extremely rare.

The newest SKAMP prototype I saw at the RCA Laboratories in Princeton, N.J., has a disk-shaped hull nine feet in diameter with a buoyancy of 4,050 pounds. It consists of a thick layer of elastomer foam sandwiched between a deck plate and a bottom plate. Should it happen to bunip into something, it would bounce off harmlessly like a rubber ball.

Two weighted, fin-like keels with integral rudders are attached, side by side, to the bottom. The keels have 20.5 square feet of projected area and the rudders have three square feet. In addition, there are two fore and aft planes added to the bottom for rotational damping.

SKAMP's gross weight is 1,800 pounds and the total height from bottom of keel to top of sail is 16.6 feet.

A pleasure boat, too. Although SKAMP is a completely integrated scientific unit, it is also a sailboat that sails just like all the manned pleasure sailboats now in use. It is quite possible for a vachtsman to visualize the unique sail developed for SKAMP on his yacht of the future. Some time ago, boatmen with an understanding and background in aerodynamics realized that if the wing of an airplane were stood on end, its lift-

ing force would act the same as the driving force produced by a sail.

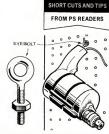
But though the airplane wing is much the same in theory and appearance as the solid-wing sail, the wind speeds in which both must function are totally different. After adjustments in the thickness and width (cord-to-camber ratio) of the solid sail had been made to permit it to operate in low wind velocities, tests proved that it was more powerful and more efficient in most conditions than was the soft canvas sail. The elimination of the mast alone produced a marked improvement in airflow and resulting drive.

A significant breakthrough, That's what was accomplished in the application of the solid-sail principle on the high-speed "C" Class catamarans that race for the "Little America's Cup." The cambered wing-shaped sail on SKAMP comprises two similar airfoil sections, made of fiberglass and filled with foam. They are sufficiently buoyant to prevent capsizing. Current low-speed wind tunnel investigations are directed toward refinement of this type of sail.

To make the whole scene even more intriguing, SKAMP sails efficiently to within 30 degrees of the wind direction. Very few conventional sailboats can sail this close to the wind.

Less efficient downwind. The wing sail is not as efficient as cloth when running directly downwind because vou cannot add more sail. You compensate for this by tacking downwind rather than running dead before it.

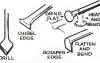
SKAMP takes a large step ahead on the nautical scene and gives vachtsmen a crystal-ball look at what might be in the future. No doubt, the sight could put "Square-Rigged Ronald" in a state of shock, but so have many other innovations that make sailboats safer, faster, and less expensive. Just don't ask your local vacht designer for a SKAMP sail-yet.



For storing power tools

The attachment of eyebolts will enable you to hang up your hand power tools on a tool board. The bolt should not interfere with any working parts of the power tool.

J. D. JOHNSON, Marietta, Ga.



Tools from bike spokes

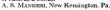
Bright steel bicycle spokes make great tools for special jobs. Heat to redness and hammer the end flat. Grind to shape to make drills, scrapers, and chisels, then harden. hooked end can be straightened and sharpened to make a scraper to form oil channels in bearings.

HENRY GOYAK, St. Louis, Mo.



Felt prevents bit spillage

Drill boxes with swing-out holders tend to spill the bits when you want to remove only one. To avoid this, cement one or more layers of felt, as needed, behind the bits in the location indicated by the pencil, above. Use enough felt to give moderate pressure against the bits. The felt will soon take a set, allowing easy removal and replacement of bits. A few drops of oil on the felt will keep the bits free of rust, as a bonus.



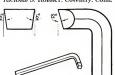






Tasteless siphoning tip

Most of us have at one time or another been stuck with mouth-siphoning gasoline, getting a mouthful in the process. A device I rigged up bypasses the nasty part. I started with a length of neoprene fuel-line hose. Then I found a bead among my daughter's old necklaces that was a slip-fit into the hose. I inserted a piece of string through the hole in the bead, as shown in the drawing, and attached a length of wire to the string for easier threading through the hose. Then, with the bead seated at one end, I inserted the hose into the gasoline container. Holding the exposed end of the wire, I slowly pulled the bead through, creating a vacuumand out flowed the gas in a stream that soon filled the container. RICHARD S. ROBSKY, Coventry, Conn.



Cutter for model work

For fluting connecting rods and eccentric straps on model locomotives. I found this tool just the thing. I ground the short end of a 1/8" Allen wrench as shown. It's handy for cutting fine grooves when regular boring tools are too large. E. E. HANSBROUGH, Allen Park, Mich.

New uses for magnets

I am always finding new jobs for magnets. One is as a holder for a magnifying glass that sticks to the blade when filing fine-tooth handsaws. Fasten a metal strip with screw holes at both ends to a magnet, with a hole drilled and tapped in the case.

Another is using one as a magnetic grip for keeping cards in place while you are copying. Cement a small bar magnet at the rear of the base of your pen stand. A small hinge is attached to the stand's edge. Set the card against the magnet, flip the hinge, and you're in business

PETER LEGON, Malden, Mass.

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By Victor B. Mason

I am printing my message in a maga-I am printing my message in a maga-zine. It may come to the attention of thousands of eyes. But of all those thousands, only a few will have the vision to understand. Many may read; but of a thousand only you may have the intuition, the sensitivity, to understand that what I am writing may be intended for you-may be the tide that intended for you—may be the fide that shapes your destiny, which taken at the crest, carries you to levels of inde-pendence beyond the dreams of avarice. Don't misunderstand me. There is

no mysticism in this. I am not speaking of occult things, of innumerable laws of nature that will sweep you to success without effort on your part. That sort of talk is rubbish! And anyone who tries to tell you that you can think your way to riches without effort is a false friend. I am too much of a

realist for that. And I hope you are.

I hope you are the kind of man—if you have read this far—who knows that anything worthwhile has to be earned! I hope you have learned that there is no reward without effort. If you have learned this. then you may be ready to take the next step in the development of your karma—you may be ready to learn and use the secret I have to impart.

I Have All The Money I Need

In my own life I have gone beyond the need of money. I have it. I have gone beyond the need of gain. I have two businesses that pay me an income well above any amount I have need for. And, in addition, I have the satisfaction-the deep satisfaction-of knowing that I have put more than three hundred other men in businesses of their own. Since I have no need for money, the greatest satisfaction I get from life is sharing my secret of personal independence with others—seeing them achieve the same heights of happiness that have come into my own life.

Please don't misunderstand this statement, I am not a philanthropist, I believe that charity is something that no proud man will accept. I have never seen a man who was worth his salt who would accept something for nothing. I have never met a highly successful man whom the world respected who did not sacrifice something to

gain his position. And, unless you are willing to make at least half the effort, I'm not interested in giving you a "leg up" to the achievement of your goal. Frankly, I'm going to charge you something for the secret I give you. Not a lot—but enough to make me believe that you are a little above the fellows who merely "wish" for success and are not willing to sacrifice something to get it.

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Don't put this off. It may be a coincidence that you are reading these words right now. Or, it may be a matter that is more deeply connected with your destiny than either of us can say. There is only one thing certain: If you have read this far you are interested in the kind of independence I enjoy. And if that is true, then you must take the next step. No coupon on this advertisement. If you don't think enough of your future happiness and prosperity to write your name on a postcard and mail it to me. forget the whole thing. But if you think there is a destiny that shapes men's lives, send your name now. What I send you may convince you of the truth of this proverb. And what I send you will not cost a penny, now or at any other time.

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